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# POLLUTION OF THE MIDDLE REACH OF THE SAVANNAH RIVER IN THE STATES OF GEORGIA AND SOUTH CAROLINA. PROCEEDINGS OF CONFERENCE HELD AT AUGUSTA, GEORGIA ON MARCH 22-23, 1972. TRANSCRIPT OF PROCEEDINGS

Environmental Protection Agency
Atlanta, Georgia

23 March 1972

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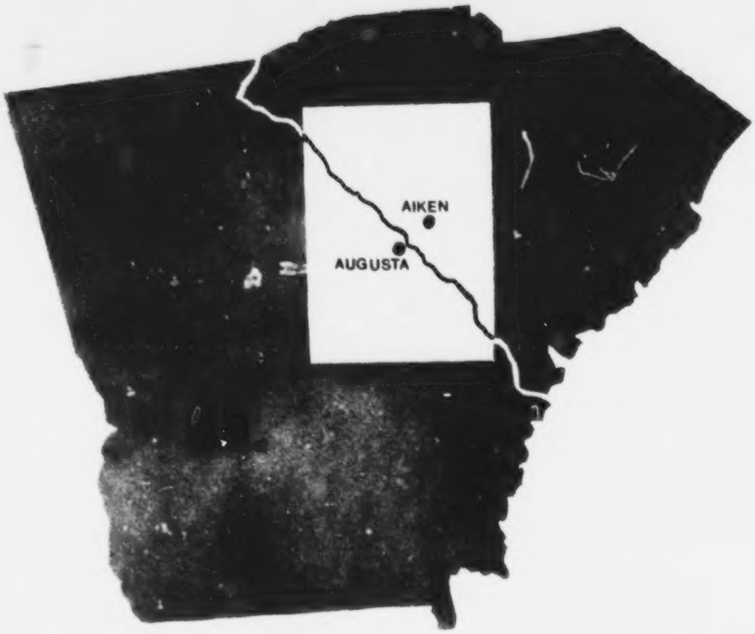

held at
Augusta, Georgia
March 22-23, 1972

Conference

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## In the matter of Pollution of the Middle Reach of the Savannah River in the States of Georgia and South Carolina

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

525

# C O N F E R E N C E

# IN THE MATTER OF
# POLLUTION OF THE MIDDLE REACH
# OF THE SAVANNAH RIVER IN THE STATES
# OF GEORGIA AND SOUTH CAROLINA

held at

Augusta, Georgia

March 22-23, 1972

TRANSCRIPT OF PROCEEDINGS

# CONTENTS

| | PAGE |
|---|---|
| Opening Statement - Mr. White | 5 |
| J. A. Little | 11 |
| B. J. Carroll | 252 |
| A. B. Foster, Jr. | 261 |
| W. H. Cloward | 276 |
| Col. H. L. Strohecker | 295 |
| G. H. Giboney | 309 |
| J. A. Westbrook | 316 |
| M. A. Beckum | 319 |
| H. O. Weeks | 324 |
| R. L. Walters | 326 |
| H. F. Zimmerman | 333 |
| R. S. Magruder | 346 |
| C. White | 355 |
| T. Champion | 361 |
| H. W. Hair, Jr. | 364 |
| J. L. Ledbetter | 366 |
| G. D. Barnes | 370 |
| W. M. Jernigan | 378 |
| J. D. Heriot | 401 |
| C. Williams | 427 |
| W. C. Lott | 429 |

# CONTENTS

(Continued)

Page

J. R. Johnson---------------------------------------- 466

R. A. Jankowski-------------------------------------- 478

W. F. Thompson--------------------------------------- 481

Conclusions and Recommendations---------------------- 501

- - -

> the report was

A Conference in the Matter of Pollution of the Middle Reach of The Savannah River in the States of Georgia and South Carolina convened at 9:30 o'clock on March 22, 1972, at the Holiday Inn, Augusta, Georgia.

> It includes statements, recommendations, and discussions of waste discharge; water quality surveys; and related information

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# PROCEEDINGS

## OPENING STATEMENT

BY

MR. JOHN C. WHITE

MR. WHITE: The conference in the matter of pollution of the middle reach of the Savannah River in the States of Georgia and South Carolina is being held under the provisions of Section 10 of the Federal Water Pollution Control Act, as amended. Under the provisions of the Act, the Administrator of the Environmental Protection Agency is authorized to initiate a conference of this type when on the basis of reports, surveys, or studies he has reason to believe that pollution of interstate or navigable waters which endanger the health or welfare of any persons is subject to abatement under the Federal Act.

As specified in Section 10 of the Act, the first step of these procedures was initiated by notifying the official State water pollution control agencies of this conference. These agencies are the Georgia Water Control Board and the South Carolina Pollution Control Authority.

Both the State and Federal Governments have responsibilities in dealing with water pollution control problems. The Federal Water Pollution Control Act declares that the States have primary rights and responsibilities for taking action to abate and control pollution. Consistent with this we are charged by law to encourage the States in these activities. At the same time, the Administrator of the Environmental Protection Agency is charged by law with specific responsibilities in the field of water pollution control in connection with pollution of interstate and navigable waters.

The Federal Water Pollution Control Act provides that pollution of interstate or navigable waters which--excuse me--provides that pollution of interstate or navigable waters which endangers the health or welfare of any person shall be subject to abatement. This applies whether the matter causing or contributing to the pollution is discharged directly into such waters or reaches such waters after discharge into a tributary.

The purpose of the conference is to bring together the State water pollution control agencies, representatives of the Environmental Protection Agency, and other interested parties to review the existing situation and the progress which has been made to lay a basis for future action by all parties concerned and to give the States, localities and industries an opportunity to take any indicated remedial action under State and local law.

## Opening Statement - Mr. White

The Georgia Water Quality Control Board will be represented by Mr. R. S. Howard, Jr. And the South Carolina Pollution Control Authority will be represented by Mr. Ken Tinsley.

The Federal conferee is Mr. Paul Traina, Director of the Water Programs Branch, Headquarters in Atlanta, Georgia.

My name is John C. White. I am Director of Enforcement Division of the Atlanta Regional Office and have been designated Conference Chairman by Mr. Ruckelshaus.

The parties to this conference are the official State water pollution control agencies and the Environmental Protection Agency. Participation in this conference will be open to representatives and invitees of these agencies and such persons as inform me that they wish to present statements.

The respective State water pollution control agencies have notified all local agencies with waste discharges within the conference boundaries and each has been invited to attend and participate in this conference. However, only the representatives of the State water pollution control agencies and the Environmental Protection Agency constitute the conferees. We do not permit any questions or comments from the floor at any time.

And now a word further about procedures which will be followed. The conferees will be called on to make a statement. In addition the conferees may call upon participants whom they have invited to the conference to make statements. We also will call upon all interested parties who have indicated on the registration cards that they wish to make a statement to give them an opportunity to make one. In other words, everyone who wants to will be given an opportunity to address the conferees.

At the conclusion of these statements, I will ask the conferees to either comment or to ask questions. Only the conferees will be given the privilege of asking questions. However, if you feel you have anything to say relative to something that was presented sometime during the conference, if you would make a note you can come to the lectern and make your statement at the appropriate time.

At the end of all the statements, the conferees will go into executive session and try to arrive at a basis of agreement on the facts of the situation. Then we shall attempt to summarize the conference by developing preliminary conclusions and recommendations. Hopefully these will be unanimous. If so, they will be read at the end of the conference and forwarded to Mr. Ruckelshaus for his approval in accordance with Section 10 of the Federal Act. The summary will not have official standing until the approval is received.

Opening Statement - Mr. White

A record and verbatim transcript of these proceedings are kept, are being made by Mrs. Rankin, and we will have a printed transcript of the conference proceedings. It will take anywhere from 3 to 6 months to get this publication out, and should any of you in the interim have any interest in looking into anything that was presented here, I would suggest that you contact Mrs. Rankin, who is an independent contractor, and she can take care of any requests you might have.

When the summary and transcripts become available, we will make sufficient copies available to the State agencies for distribution to each of you who indicated on the registration card that you would like to receive one or depending upon how the States would prefer to handle it we could mail them directly out of Atlanta to you at the time that they are completed.

I would like to indicate that we don't print anything in color, so take this into account if you are making a presentation using any visual aids which use color to depict any particular circumstance.

I would also suggest that as you are called to come to make a statement that you proceed to the lectern and identify yourself for the record. If you have a copy of a prepared statement, we would appreciate it if you would give it to Mrs.

Rankin, and if you have sufficient copies to go around it would be helpful if the conferees had a copy.

With that brief opening statement, I would now like to ask the conferees if they have any statement to make at this time.

MR. HOWARD: We have a statement.

MR. WHITE: Mr. Tinsley?

MR. TINSLEY: We have a prepared technical statement.

MR. WHITE: Both States have indicated that they will have a prepared statement that will be made later in the program.

I will now call on Mr. Traina for the Federal presentation.

MR. TRAINA: Thank you, Mr. White.

I in turn would like to call on Mr. John A. Little, who is with our Water Laboratory in Athens, for the Federal report.

I might just add as Mr. Little is getting up, copies of this report, I believe, are available at the back.

JOHN A. LITTLE, DIRECTOR
SURVEILLANCE AND ANALYSIS DIVISION
REGION IV
U.S. ENVIRONMENTAL PROTECTION AGENCY
ATHENS, GEORGIA

MR. LITTLE: Thank you, Mr. Chairman, conferees and ladies and gentlemen.

My name is John A. Little. I am Director of the Surveillance and Analysis Division of Region IV, Environmental Protection Agency.

At this time I would like to read into the record a portion of a report entitled "A Report on Pollution in the Middle Reach of the Savannah River, Georgia-South Carolina," revised February 1972. Mr. Chairman, I would like to have this introduced in toto into the record.

MR. WHITE: It will be accepted in the record, without objection, as if read.

(The above-mentioned report follows:)

# A REPORT ON POLLUTION IN THE MIDDLE REACH OF THE SAVANNAH RIVER
## GEORGIA - SOUTH CAROLINA

Environmental Protection Agency
Southeast Water Laboratory
Technical Services Program
Athens, Georgia

August 1971

Summary, Conclusions and Recommendations

Revised February 1972

Technical Study Report Number TS 03-71-208-003

# A REPORT ON POLLUTION IN THE MIDDLE REACH OF THE SAVANNAH RIVER
## GEORGIA - SOUTH CAROLINA

Environmental Protection Agency
Southeast Water Laboratory
Technical Services Program
Athens, Georgia

August 1971

Technical Study Report Number TS 03-71-208-003

# TABLE OF CONTENTS

Title — Page No.

INTRODUCTION . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1

SUMMARY AND CONCLUSIONS. . . . . . . . . . . . . . . . . . . . . . . 3

Summary . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

Conclusions . . . . . . . . . . . . . . . . . . . . . . . . . . 5

RECOMMENDATIONS. . . . . . . . . . . . . . . . . . . . . . . . . . . 7

DESCRIPTION OF STUDY AND STUDY AREA . . . . . . . . . . . . . . . . . 10

Study Area. . . . . . . . . . . . . . . . . . . . . . . . . . . 10

Study Program . . . . . . . . . . . . . . . . . . . . . . . . . 14

WASTE DISCHARGES AND WATER QUALITY . . . . . . . . . . . . . . . . . 15

Georgia Waste Sources and Tributary Streams . . . . . . . . . . . . 15

South Carolina Waste Sources and Tributary Streams. . . . . . . . . 20

Savannah River Water Quality. . . . . . . . . . . . . . . . . . . 24

APPENDICES

Appendix A, Sampling Locations, Sampling Procedure, and Analytical Methodology

Appendix B, Bacterial Water Quality - Middle Reach of the Savannah River

Appendix C, Biological Studies - Middle Reach of the Savannah River

## LIST OF FIGURES

| Number | Title | Follows Page No. |
|---|---|---|
| 1 | Savannah River Study Area | 10 |
| 2 | Schematic of Waste Sources | 15 |
| 3 | Savannah River Plant Study Area | 24 |
| 4 | Dissolved Oxygen and BOD, Savannah River - Augusta Area | 24 |
| 5 | Nitrogen Compounds, Savannah River - Augusta Area | 25 |

## LIST OF TABLES

| Number | Title | Follows Page No. |
|---|---|---|
| 1 | Average Waste Loadings - Savannah River. . . . . . . . . . . . | 15 |
| 2 | Average Waste Loadings - Georgia Sources . . . . . . . . . . . | 16 |
| 3 | Water Quality Summary - Augusta Industrial Canal and Tributaries . . . . . . | 17 |
| 4 | Water Quality Summary - Butler Creek and Tributaries . . . . | 18 |
| 5 | Water Quality Summary - Spirit Creek . . . . . . . . . . . . . | 19 |
| 6 | Average Waste Loadings - South Carolina Sources. . . . . . . | 20 |
| 7 | Water Quality Summary - Horse Creek. . . . . . . . . . . . . . | 20 |
| 8 | Water Quality Summary - Kelly Creek. . . . . . . . . . . . . . | 21 |
| 9 | Water Quality Summary - Little Horse Creek . . . . . . . . . . | 22 |
| 10 | Water Quality Summary - Lower Three Runs Creek . . . . . . . | 23 |
| 11 | Water Quality Summary - Savannah River Plant . . . . . . . . . | 24 |
| 12 | Water Quality Summary - Savannah River . . . . . . . . . . . . | 24 |
| 13 | Savannah River - Sediment COD. . . . . . . . . . . . . . . . . | 25 |

# INTRODUCTION

A water quality survey of the Savannah River from seven miles north of Augusta, Georgia to approximately seventy-five miles southeast of Augusta, was conducted during July-August 1970. The survey included the identification of waste sources and water quality in the main stem and major tributary streams in both Georgia and South Carolina. Water quality on tributary streams within the AEC Savannah River Plant area was examined during October 1970.

This survey was requested by the Georgia Water Quality Control Board and concurred with by the South Carolina Pollution Control Authority. Extensive assistance was provided by both agencies during the planning and operations phases of this project. Full cooperation was received from the Atomic Energy Commission, as well as the numerous municipal and industrial entities examined. The Savannah District of the U. S. Army Corps of Engineers provided valuable information on the hydrological characteristics of the Savannah River. The successful completion of this report could not have been accomplished without the contributions of these agencies, and their assistance is gratefully appreciated and acknowledged.

The summary, conclusions, and recommendations have been revised to reflect information available to the Environmental Protection Agency as of February 1972. The body of the report has not been revised and it is recognized that conditions may have changed since the report was written. Accordingly, in a few instances statements in the summary, conclusions, and recommendations may differ from those of the text.

## SUMMARY AND CONCLUSIONS

### Summary

The current Georgia fecal coliform bacteria criteria of 5,000/100 ml was exceeded from just north of the City of Augusta and Hawks Gully outfalls to downstream of Spirit Creek, a distance of 18 miles. Except for locations upstream from all waste sources, pathogenic Salmonella were isolated at all Savannah River stations in the 74 mile reach sampled.

Dissolved oxygen below 5.0 mg/l was not detected in the Savannah River during the period of this study; however, a diurnal study of dissolved oxygen showed that wastes originating in the reach of the river between Hawks Gully and Horse Creek were of sufficient magnitude to noticeably reduce the oxygen assets of the Savannah River.

1. The Savannah River, middle reach, receives daily wastes with a 5-day Biochemical Oxygen Demand ($BOD_5$) of 73,200 pounds. These wastes are equivalent to the untreated wastes discharged by a human population of 439,000. Sixty-one percent of the waste loads measured are from Georgia sources. The remaining 39 percent are from sources located in South Carolina.
2. The major sources of wastes originating in Georgia enter the Savannah River from the City of Augusta, Columbia Nitrogen Corporation, Olin Mathieson Corporation, and grossly polluted flow from Butler Creek, Hawks Gully and Spirit Creek.
3. It is estimated that only about 45 percent of the total municipal water supply for the Augusta, Georgia, area reaches the sewage treatment system. Approximately twelve million gallons per day (MGD) of wastes are routed through the Augusta sewage treatment plant, a primary facility, with $BOD_5$ removal efficiencies less than 40 percent. (Revised to reflect recent information).

4. Columbia Nitrogen Corporation Caprolactam Plant discharges approximately 3,000 pounds per day of $BOD_5$ directly to the Savannah River. This waste exhibits toxic or growth inhibiting characteristics. A total nitrogen load of 3,700 pounds is also discharged daily to Beaverdam Ditch from the nitrogen plant.
5. Olin Corporation discharges less than a quarter of a pound per day of mercury.
6. Mean fecal coliform bacteria density in Hawks Gully outlet was 20,000/100 ml, and Salmonella organisms, which are pathogenic to man and other warm-blooded animals, were isolated.
7. Butler Creek, at the confluence with the Savannah River, contained an average dissolved oxygen of 0.5 mg/l, $BOD_5$ of 47.9 mg/l, and fecal coliform bacteria density of 5,900,000/100 ml.
8. Indirect drainage to Butler Creek from Camille Ditch, Rocky Creek, Gwinnett Street Ditch, and Oates Creek contained dissolved oxygen concentrations of zero, 1.4, zero, and 4.0 mg/l respectively. The upper reach of Beaverdam Ditch, a tributary to Butler Creek, has undetectable dissolved oxygen, 173 mg/l of $BOD_5$, and a mean fecal coliform bacteria of 9,300,000/100 ml. The other Butler Creek tributary, Phinizy Creek, receives up to 8,470 pounds per day of $BOD_5$, from the Augusta sewage treatment plant.
9. Spirit Creek receives daily 1.7 MG of secondary treated chlorinated effluent from the Fort Gordon sewage treatment plant. It also receives 11,300 pounds of $BOD_5$ from the Continental Can-Cox Newsprint Paper Mill. Dissolved oxygen downstream of the paper mill discharge averages 0.1 mg/l and $BOD_5$ 22 mg/l. This discharge

increased the color in Spirit Creek from 57 to 472 color units. (Revised to reflect recent information -- previously the discharge was not chlorinated).

10. Major waste discharges entering the Savannah River from South Carolina are from the City of North Augusta, Kimberly Clark, the Atomic Energy Commission's Savannah River Plant, and grossly polluted flow from Horse Creek and Lower Three Runs Creek.

11. The City of North Augusta has no waste treatment facilities. Raw wastes discharged directly into the river contained pathogenic Salmonella and a mean fecal coliform bacteria density of 24,000,000/100 ml.

12. The daily discharge from Kimberly Clark Paper Company waste lagoons contained 450 pounds of $BOD_5$, 575 pounds suspended solids, and a mean fecal coliform bacteria density of 170/100 ml

13. Waste treatment facilities at the AEC Savannah River Plant consist of waste stabilization ponds and septic tanks.

14. The Cities of Aiken and Warrenville and the Gregg Mill, Bath Mill, Seminole Mill, Valchem Chemical Company, and Clearwater Finishing Plant discharge 55,000 pounds of $BOD_5$ to Horse Creek and its tributaries. Approximately 23,200 pounds of this wasteload reaches the Savannah River.

15. Bottom muds in Horse Creek near the confluence with the Savannah River contained 990 mg/kg of chromium which is toxic to bottom organisms and destroys fish and spawning areas. Approximately 305 pounds per day of chromium flow into the Savannah River from Horse Creek.

16. Sludge deposits in the Savannah River downstream from Horse Creek contained 670 mg/kg of chromium, while immediately upstream chromium concentrations were 32 mg/kg.

17. The J. P. Stevens Mill in Allendale County discharges sanitary and wool scouring wastes into Davis Branch, a tributary to Lower Three Runs Creek. At the time of the study, this waste had a population equivalent of 43,000 and severely degraded the water quality in Lower Three Runs Creek. South Carolina Pollution Control Authority Order Number 70-4-W issued March 11, 1970 called for a cessation of their pollution and construction of adequate waste treatment facilities by March 23, 1971.

## Conclusions

Discharges of untreated and inadequately treated municipal and industrial wastes originating in Georgia and South Carolina cause interstate pollution of the Savannah River (middle reach), endangering the health and welfare of persons in both states. This pollution is subject to abatement under the provision of Section 10 of the Federal Water Pollution Control Act as amended (33 USC 1160).

1. Untreated waste discharges from the sewer system serving downtown Augusta, Georgia, and North Augusta, South Carolina, contribute fecal coliform bacteria contamination to the interstate waters of the Savannah River.
2. None of the wastes discharged to the Savannah River from the Augusta, Georgia, Sewage Treatment Plant are receiving adequate treatment.
3. Chromium deposits causing interstate pollution of the Savannah River result from waste discharges from the Gregg Mill, Valchem Chemical Company, and Clearwater Finishing Plant.
4. Butler Creek, at the confluence with the Savannah River, is grossly polluted by the discharge of 12 MGD of inadequately treated municipal waste from the Augusta sewage treatment plant and from grossly polluted interior drainage from the Augusta, Georgia, area. (Revised to reflect recent information).
5. Oates Creek, Camille Ditch, Rocky Creek, Phinizy Ditch, and Beaverdam Ditch receive untreated and inadequately treated municipal and industrial wastes from the Augusta, Georgia, area and are little more than open sewers.

6. Spirit Creek is grossly polluted by the discharge from the Continental Can-Cox Newsprint Paper Mill. (Revised to reflect recent information).

7. Horse Creek and its tributary, Little Horse Creek, are grossly polluted from the discharge of more than 11 MGD of untreated textile mill wastes and more than 1.3 MGD of raw and inadequately treated sanitary wastes.

8. Water quality in Horse Creek violated water quality standards adopted by South Carolina.

9. Kimberly Clark Company was providing adequate treatment for its wastes, and the effluent did not have a measurable effect on water quality in the Savannah River

10. Organic wastes and thermal discharges receiving inadequate treatment from facilities serving the AEC Savannah River Plant cause localized water quality degradation in plant tributaries with no noticeable effect on water quality in the Savannah River.

## RECOMMENDATIONS

IT IS RECOMMENDED THAT

1. The City of Augusta upgrade the Butler Creek sewage treatment plant to secondary treatment with a minimum of 85 percent $BOD_5$ removal by June 1973. All wastes now being discharged without treatment, either directly to the Savannah River or to the existing city collection system, be transported to the Butler Creek sewage treatment plant by June 1973. Effective disinfection of plant effluent be provided at all times.

2. The City of Augusta, Georgia, and the County of Richmond, Georgia, enforce their sewer use ordinances.

3. The City of Augusta institute a program of separating existing combined storm and sanitary sewers and extending collection and interceptor lines to all sections of the Augusta, Georgia, metropolitan area. A report on the feasibility of the sewer separation program be submitted to the conferees by January 1. 1973.

4. The Columbia Nitrogen Corporation Caprolactam Plant and Nitrogen Plant provide the equivalent of secondary treatment to their wastes by December 1972.

5. The Continental Can-Cox Newsprint waste treatment lagoons be upgraded to provide at least 85 percent reduction of organic wastes by December 1972. These lagoons should discharge directly into the Savannah River instead of into Spirit Creek. When applied technology becomes available, the color in the effluent should be reduced to background in the Savannah River at the point of discharge.

6. The City of North Augusta, South Carolina, install and operate satisfactory secondary waste treatment facilities as required

by the South Carolina Pollution Control Authority under Order 70-10-W issued April 21, 1970.

7. The J. P. Stevens Company install and properly operate waste treatment facilities to remove at least 85 percent of the organic material by April 30, 1972.

8. The Gregg Mill of the Graniteville Textile Company, the Valchem Chemical Company and the Clearwater Finishing Plant, subsidiaries of United Merchants and Manufacturing Company, immediately eliminate chromium from their waste discharges.

9. A feasibility study report for a waste collection system and a centralized waste treatment facility for the entire Horse Creek Valley be submitted to the conferees by December 31, 1972. Discharge from this facility will be directly to the Savannah River.

10. The Atomic Energy Commission's Savannah River Plant provide secondary treatment of domestic waste in accordance with Executive Order 11507. These facilities should be operational by December 1972.

11. The States of Georgia and South Carolina develop consistent water use classifications and water quality criteria for the Savannah River

12. The State of Georgia classify all major tributary streams to the Savannah River. Discharge limits for industrial sources be established by the Environmental Protection Agency in cooperation with the State of Georgia through the 1899 Refuse Act Permit Program to ensure that water quality criteria will be met.

13. Discharge limits be established for Horse Creek industrial waste sources by the Environmental Protection Agency in cooperation with the State of South Carolina through the 1899 Refuse Act Permit Program to ensure that established water quality criteria are met.

## DESCRIPTION OF STUDY AND STUDY AREA

### Study Area

The study area includes the Augusta Standard Metropolitan Statistical Area (SMSA) (Richmond County, Georgia and Aiken County, South Carolina), the AEC Savannah River Plant and adjacent industries located in Barnwell and Allendale Counties, South Carolina (Figure 1). The Augusta SMSA covers 1,416 square miles and is the terminal point of navigation on the Savannah River. The population of the study area counted by the 1970 census is:

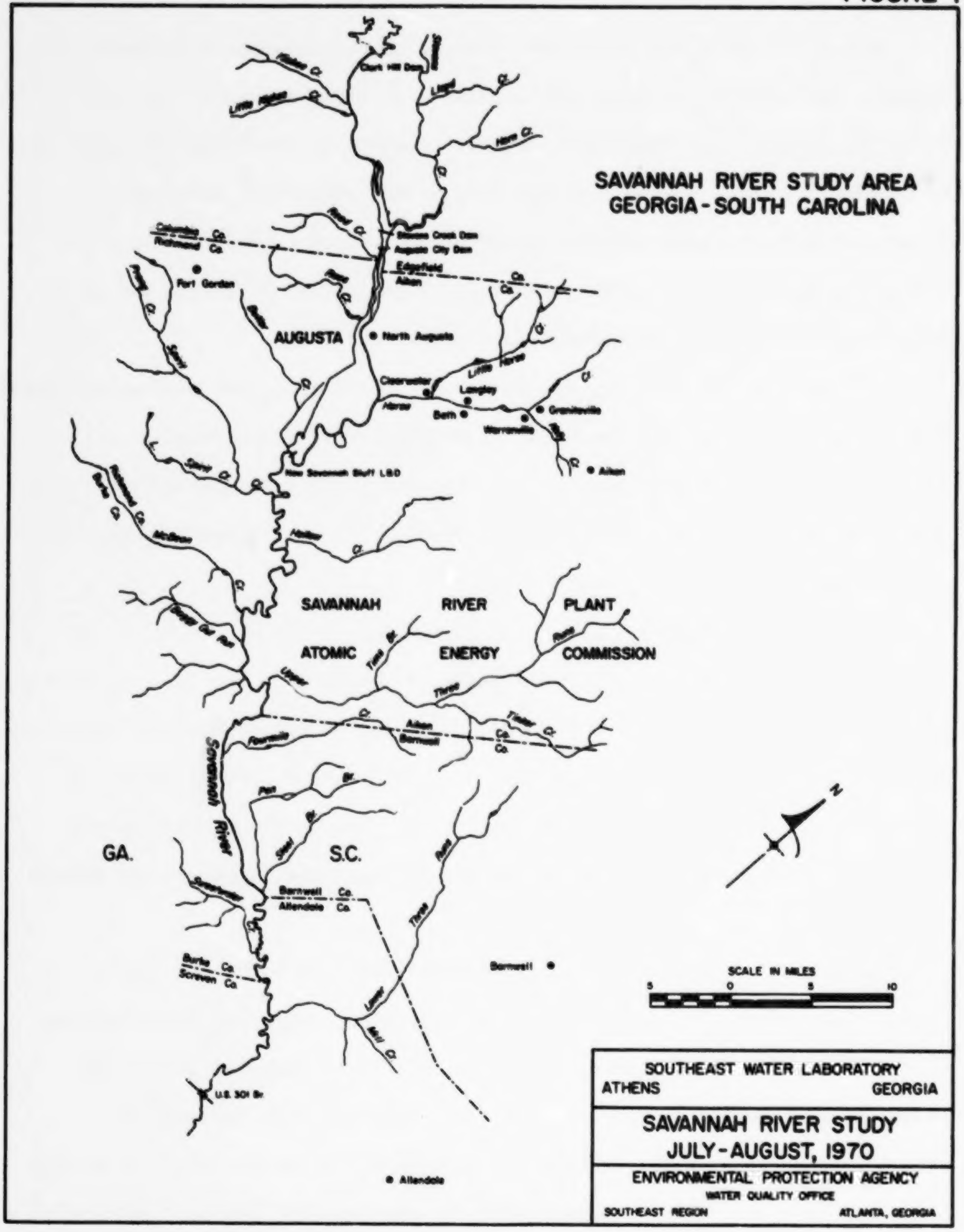
Area Population

| | 1970 |
|---|---|
| Augusta SMSA | 253,460 |
| City of Augusta, Georgia | 59,864 |
| Aiken County, South Carolina | 91,023 |
| Richmond County, Georgia | 162,437 |
| | 1985 Projection* |
| Augusta SMSA | 393,000 |

* Gould Associates, Augusta-Richmond County Planning Commission, "Economic Analysis Augusta-Richmond County," 1969.

The manufacture of textiles, chemicals, pulp and paper along with brick and tile dominate the industrial economy of the area. Richmond and Aiken Counties, as of 1964, employed 8,900 people in the textile industry -- 3,400 employed in Augusta and the remainder in the famed Horse Creek Valley where 14 textile plants represent annually a $15,000,000 payroll and cotton goods valued at $50,000,000.

FIGURE I


Clark Hill Dam
Little Horse Cr.
Cr.
Horn Cr.
Stevens Creek Dam
Augusta City Dam
Columbia Co.
Richmond Co.
Edgefield Co.
Aiken Co.
Fort Gordon
AUGUSTA
North Augusta
Little Horse
Clearwater
Langley
Horse
Bath
Graniteville
Warrenville
Aiken
New Savannah Bluff L&D
Spirit
Butler
Cr.
Richmond Co.
Burke Co.
McBean
Hollow
Cr.
Steel Creek
SAVANNAH RIVER PLANT
ATOMIC ENERGY COMMISSION
Upper
Three
Runs
Tims Br.
Tinker Cr.
Aiken Co.
Barnwell Co.
Fourmile
Savannah River
Pen Br.
Steel Br.
GA.
S.C.
Runs
Three
Lower
Barnwell Co.
Allendale Co.
Burke Co.
Screven Co.
Mill Cr.
Barnwell
U.S. 301 Br.
Allendale
N
SCALE IN MILES
5
0
5
10

SAVANNAH RIVER STUDY AREA
GEORGIA - SOUTH CAROLINA

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

During the '60's the industrial base of this geographic area began to change. Agriculture products and textiles were being joined by the fast expanding chemical and paper industries. Location of a $45,000,000 paper mill by Continental Can provided the impetus for this industrial development. Industrial parks to accommodate this growth have been established at three sites in Augusta: Miracle Mill, Continental Industrial District, and an industrial district on Gwinnett Street Extension.

Historically the military has played a vital role in the economy of Augusta. The military and civilian complement at the military establishments in this area have tended to fluctuate markedly over the years. Presently, Ft. Gordon (Figure 1) has a military complement of 30,000 plus an estimated 3,000 civilian employees.

Employment projections indicate the heaviest numerical growth in non-durables which includes the big water users -- paper and chemicals. Textiles and the stone, clay, and glass industries will have only a moderate increase. Mining, which is presently very small, will have a 50 percent increase in employment. If technological advancements are made in the extraction and processing of aluminum from kaolin, this could drastically change the mining in this area.

The area is approximately 135 feet above mean sea level and presents a varied topography. The "fall line" (the line along which the rocky terrain of the Piedmont foothills meets the sandy soil of the coastal plain area) passes through Augusta. The surface of the area has been reduced by stream erosion to a series of broad level ridges and valleys with gentle to steep slopes. The terrain slopes gently to the Atlantic seaboard and consists of unconsolidated sand and clay.

The area climate is characterized by hot summers (temperatures exceeding 100°F are common) and mild winters. The lowest rainfall occurs in October and November; the greatest during the summer months.

Climate

| Augusta SMSA | Temperature (°F) |
|---|---|
| Mean Winter | 47.3° |
| Mean Summer | 79.2° |
| Mean Annual | 64.0° |
| Avg. Yrly. Rainfall (in.) | 39.18 |

Flow regimen in the Middle Savannah River (Augusta to Port Wentworth) is regulated directly by Clark Hill Dam, and to a lesser degree by upstream dams at Hartwell, Lake Burton, and Lake Mathis. Clark Hill and Hartwell reservoirs have a combined storage equivalent to one half of the basin's yearly runoff. The average yearly flow of the Savannah River at Augusta is 10,230 cfs.

Completion of Clark Hill in 1954, 22 miles north of Augusta, opened up the river's tremendous power and navigation potential. This multi-purpose dam serves many important functions: guaranteed minimum flows, power generation, recreation, protects fish and wildlife, and prevents flooding.

The Corps of Engineers assures the City of Augusta an average minimum daily flow of 3,000 cfs at the dam. This guarantees the minimum depth of nine feet in the river channel which has developed Augusta into a year-round inland port for barge traffic. However, at the present time river traffic is limited to relatively few products. Less than a dozen barges a week travel between Augusta and Savannah.

The heaviest movements are in the shipment of petroleum products and brick and tile. The development of river transportation is expected to play a major role in Augusta's future economy.

Seven miles above Augusta a low-head dam diverts an average daily weekday flow of 2,800 cfs into Augusta's Industrial Canal. It was built for water supply and power. Presently, King Mills, Sibley, and Enterprise Divisions of Graniteville Mills use the canal's water power. Augusta's water treatment plant withdraws an average of 27 MGD from the canal for potable water supply. Weekend flows in the canal are reduced because the mills shut down.

The Savannah River, an interstate stream, has been classified for water use by Georgia and South Carolina. Tributaries to the Savannah River in Georgia have not been classified but are generally assumed to carry the same classification as the receiving waters. Savannah River classifications are as follows:

| Stream Reach | Water Use Classification | Criteria |
|---|---|---|
| Clark Hill Dam to Augusta 13th St. Bridge | (Ga. & S.C.) Drinking Water | DO: Ga. & S.C. $\geq$ 4 mg/l<br>pH: Ga. 6.0 - 8.5<br>S.C. 6.0 - 8.0<br>Fecal Coliform:<br>Ga.- Not to exceed a mean of 5,000 per 100 ml based on at least 4 samples over 30-day period & not to exceed 20,000/100 ml in more than 5% of samples taken in any 90-day period.<br>S.C.- Not to exceed 2,000/100 ml as a monthly arithmetic average. |
| Augusta 13th St. Bridge to Upper Three Runs Confluence | (Ga. & S.C.) Fish & Wildlife | DO: Same as above.<br>pH: Same as above.<br>Fecal Coliform:<br>Ga.- Same as above.<br>S.C.- None. |

| Stream Reach | Water Use Classification | Criteria |
|---|---|---|
| Upper Three Runs Confluence to U.S. Hwy 301 Bridge | Ga. - Fish & Wildlife<br>S.C. - Drinking Water | Same as above. |

Both states have general criteria which are applicable to all waters. General criteria for both states' discharges requires all to be free from substances in amounts, concentrations, or combinations which are harmful to humans, animals, or aquatic life.

Study Program

Three primary objectives were established for water quality evaluation:

1. To ascertain quantity and quality of municipal and industrial waste discharges in the Augusta-Aiken metropolitan area and their effects on tributary streams and the interstate waters of the Savannah River.
2. To determine whether State-Federal water quality criteria are met in the study area and make recommendations for correction of these problems.
3. To determine the effects of thermal discharges on the quality and uses of the Savannah River.

The first two objectives were pursued during July-August 1970 with chemical, bacteriological, and biological studies being conducted concurrently. Appendices B and C contain results of the bacteriological and biological studies respectively. Objective 3 was evaluated October 1970 and is also referenced in Appendices B and C.

That information pretaining to sampling locations and procedure and analytical methodology is included in Appendix A.

# WASTE DISCHARGES AND WATER QUALITY

Major waste discharges to the middle reach of the Savannah River from waste sources in Georgia and South Carolina are in the Augusta area (Figire 2). The major inputs of waste to the Savannah River from Georgia occur through Hawks Gully, Butler Creek, and Spirit Creek. Wastes from the Columbia Nitrogen Caprolactam Plant and Olin Corporation chlorine production plant discharge directly to the Savannah River and were not sampled by EPA. Input from Georgia waste sources account for 61 percent or 44,700 pounds per day of $BOD_5$ measured in discharges to the Savannah River. This is equivalent to the wastes discharged from a human population of 268,000. Wastes from sources in South Carolina are introduced through Horse Creek and Lower Three Runs Creek, as well as the raw sewage outfall from North Augusta and the secondary treated effluent from Kimberly Clark Paper Company. These sources contribute a total of 28,500 pounds per day of BOD or 39 percent of the total. This is equivalent to the wastes discharged from a human population of 171,000. Total waste loadings to the Savannah River are summarized in Table 1.

## Georgia Waste Sources and Tributary Streams

The Savannah River at Augusta receives wastes from untreated domestic and commercial discharges in the downtown Augusta area and from the King, Sibley, and Enterprise Textile Mills. The wastes from the King Mill and Sibley Mill, amounting to slightly more than 1,000 pounds per day of $BOD_5$, were scheduled to be intercepted and pumped to the Augusta municipal sewage treatment plant at Butler Creek during late summer of 1970. The Entreprise Mill, a subsidiary of the Graniteville Textile Company, discharges wastes to the city sewer system. This section of the system is not presently

## Table 1

### AVERAGE WASTE LOADINGS (LBS/DAY)
### SAVANNAH RIVER

| Source or Tributary | R.M. | Discharge (mgd) | $BOD_5$ | TOC | COD | Nitrogenous Compounds (N) | | | Phosphorus (P) | | Solids | | Metals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TKN | $NH_3$ | $NO_2$-$NO_3$ | Total | Ortho-P | N-FS | VN-FS | Cr | Hg |
| Hawks Gully | 201.2 | 503 | 10,900 | 22,000 | 28,100 | 2,390 | 1,510 | 820 | 189 | 131 | 41,950 | 18,200 | | - |
| N. Augusta Sewer Outfall | 200.7 | 0.95 | 842 | 293 | 1,420 | 105 | - | 1.0 | 59 | 57 | 887 | 697 | - | |
| Horse Creek | 197.4 | 83.3 | 23,200 | 12,290 | 40,600 | 1,210 | 318 | 13.5 | 271 | 107 | 50,260 | 12,300 | 306 | - |
| Col. Nit. Cap. Plant | 194.0 | 0.40 | - | 767 | 2,640 | 1,210 | 1,160 | 190.2 | 1.7 | 1.0 | - | - | - | - |
| Kimberly-Clark | 192.9 | 6.89 | 454 | 383 | 862 | 28.7 | 6.3 | 2.9 | 1.1 | 0.57 | 575 | 402 | - | - |
| Butler Creek | 187.0 | 54.4 | 21,700 | 12,250 | 44,010 | 4,190 | 3,800 | 58 | 2,640 | 2,210 | 19,500 | 9,530 | - | - |
| Olin Corp. | - | 1/ | - | - | - | - | - | - | - | - | - | - | | 0.074<br>0.506 |
| Spirit Creek | 182.8 | 65.5 | 12,100 | 33,000 | 87,400 | 1,110 | 224 | 8.8 | 275 | 197 | 26,500 | 16,900 | - | - |
| Lower Three Runs Creek | 129.1 | 27.8 | 3,990 | 3,660 | 10,100 | 293 | 138 | 18 | 14 | 12.5 | 3,250 | 1.970 | - | - |

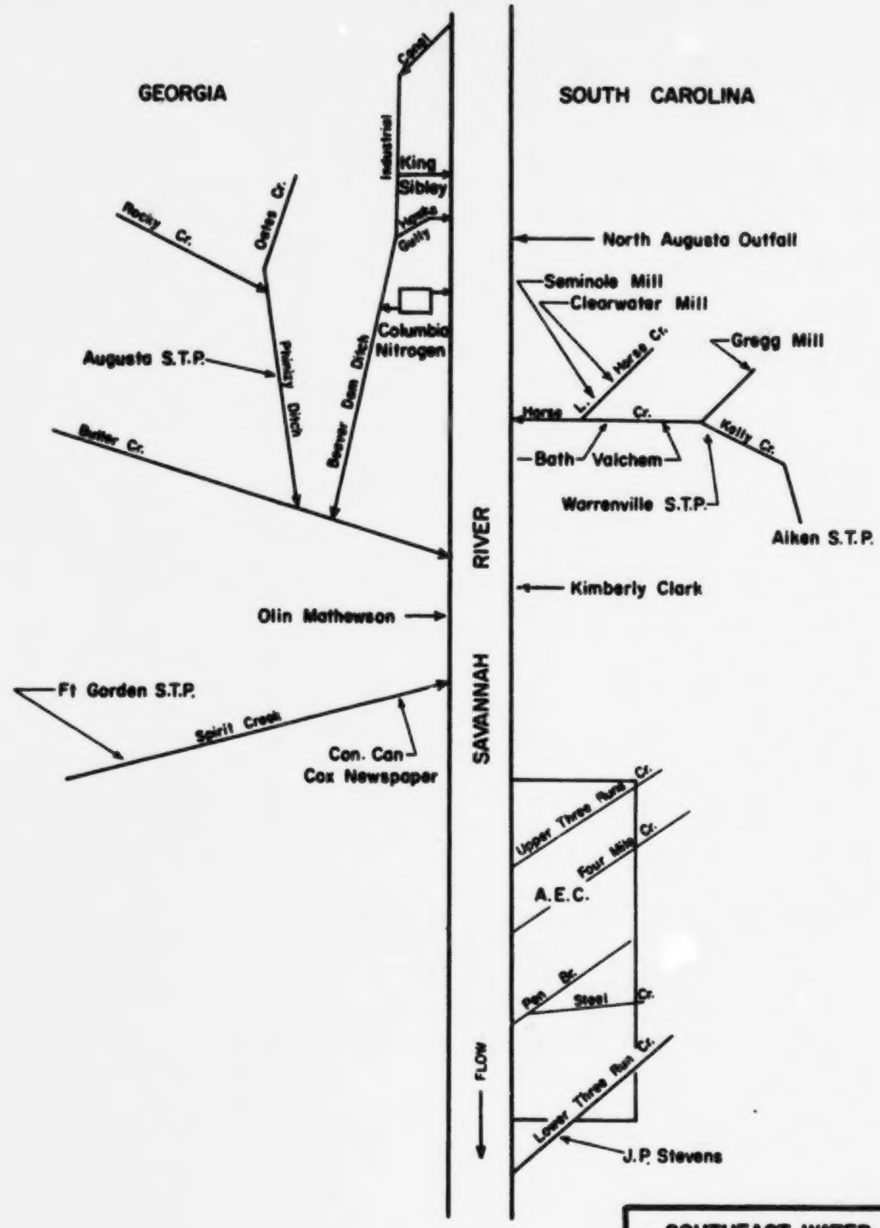
---

1/ Range of daily discharge averaged on weekly basis, October4-December 27, 1970, supplied by Olin Corporation.

- Denotes determination not made.

## FIGURE 2

## SCHEMATIC OF TRIBUTARIES AND WASTE SOURCES


GEORGIA
SOUTH CAROLINA
Canal
Industrial
King
Sibley
Hawks
Gully
Columbia
Nitrogen
Rocky Cr.
Oates Cr.
Augusta S.T.P.
Phinizy Ditch
Beaver Dam Ditch
Butler Cr.
North Augusta Outfall
Seminole Mill
Clearwater Mill
Horse Cr.
Gregg Mill
Horse
L.
Cr.
Kelly Cr.
Bath
Valchem
Warrenville S.T.P.
Aiken S.T.P.
SAVANNAH RIVER
Kimberly Clark
Olin Mathewson
Ft Gorden S.T.P.
Spirit Creek
Con. Can
Cox Newspaper
Upper Three Runs Cr.
Four Mile Cr.
A.E.C.
Pen Br.
Steel Cr.
Lower Three Run Cr.
J.P. Stevens
FLOW

NOTE: This Drawing Not To Scale

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY-AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

intercepted, and the untreated wastes eventually discharge to the Industrial Canal and to the Savannah River through Hawks Gully (Table 2). Cool water diverted from the Savannah River below Clark Hill Dam and turbulence in the Industrial Canal and Hawks Gully kept dissolved oxygen levels above 6.7 mg/l. However, BOD increased more thanthree-fold, from 0.8 mg/l to 2.6 mg/l, and ammonia nitrogen increased nearly ten times, from .045 mg/l to .40 mg/l. The mean fecal coliform bacteria density increased from 35/100 ml at the intake to the Industrial Canal to 20,000/100 ml in Hawks Gully just upstream from the confluence with the Savannah River. *Salmonella*, a pathogenic genus of bacteria, were isolated at the Augusta water supply intake, presumably upstream of all sources of waste on the Industrial Canal and at the confluence of Hawks Gully with the Savannah River. However, water samples from North Augusta's potable supply showed no evidence of bacterial contamination. The grossly increased fecal bacterial contamination in the Industrial Canal and Hawks Gully is the result of the discharge of untreated wastes to these receiving waters. Some of the contaminated water from the Industrial Canal escapes to Beaverdam Ditch, a tributary of Butler Creek. Water quality in the Augusta Industrial Canal is summarized in Table 3.

Columbia Nitrogen Corporation discharges contaminated cooling water containing 2,770 pounds per day of ammonia nitrogen and 945 pounds per day of nitrate-nitrite nitrogen. This cooling water flows through a swamp and eventually to Butler Creek. The caprolactam manufacturing process section of Columbia Nitrogen discharges some industrial and domestic wastes with the cooling water to a ditch leading directly to the Savannah River. The 0.4 MGD cooling water discharge contained 1,160 pounds per day of ammonia nitrogen and 190 pounds per day of nitrate nitrogen. The effluent is also extremely high in $BOD_5$, but toxic components of the waste prevented an

## Table 2
## AVERAGE WASTE LOADINGS (LBS/DAY)
## GEORGIA SOURCES

| Source or Tributary | Receiving Stream | Dis-charge (mgd) | $BOD_5$ | TOC | COD | Nitrogenous Compounds (N) | | | Phosphorus (P) | | Solids | | Metal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TKN | $NH_3$ | $NO_2$-$NO_3$ | Total | Ortho-P | N-FS | VN-FS | Cr | Hg |
| Hawks Gully | Savannah River | 503 | 10,900 | 22,000 | 28,100 | 2,390 | 1,510 | 820 | 189 | 131 | 41,950 | 18,200 | - | - |
| Augusta Waste-water Treat. Fac. | Butler Creek | 8.0 | 8,470 | 3,340 | 16,680 | 1,190 | 1,150 | 1.0 | 1,320 | 1,270 | 4,740 | 3,670 | - | - |
| Columbia Nitrogen | Swamp to Butler Creek | 1.1 | - | 55 | 165 | 2,970 | 2,770 | 945 | 4.1 | 2.57 | - | - | - | - |
| Col.Nit. Cap.Pl. | Savannah River | 0.40 | - | 767 | 2,640 | 1,210 | 1,160 | 190 | 1.67 | 1.03 | - | - | - | - |
| Butler Creek | Savannah River | 54.4 | 21,700 | 12,250 | 44,010 | 4,190 | 3,800 | 58 | 2,640 | 2,210 | 19,500 | 9,530 | - | - |
| Ft.Gordon STP | Spirit Creek | 1.74 | 479 | 356 | 972 | 157 | 154 | 64.4 | 87.1 | 85.6 | 377 | 218 | - | - |
| Con.Can Corp. | Spirit Creek | 37.5 | 11,260 | 47,700 | 128,200 | 1,380 | 219 | 9.38 | 254 | 172 | 25,270 | 25,300 | - | - |
| Spirit Creek | Savannah River | 65.5 | 12,100 | 33,000 | 87,400 | 1,110 | 224 | 8.8 | 275 | 197 | 26,500 | 16,900 | - | - |
| Olin Corp. | Savannah River | -1/ | - | - | - | - | - | - | - | - | - | - | - | .074<br>.056 |

1/ Range of daily discharge averaged on weekly basis, October 4-December 27, 1970, supplied by Olin Corp.

- Denotes determination not made.

accurate assessment. Samples analyzed by the Georgia Water Quality control Board showed an average $BOD_5$ concentration of 930 mg/l, or 3,000 pounds per day discharged to the Savannah River.

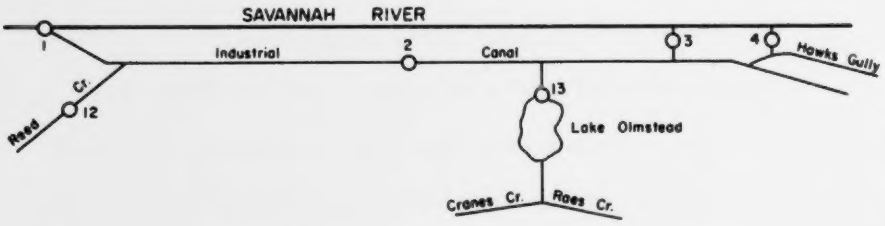
The interior creeks in the Augusta, Georgia, area, such as Oates Creek, Camille Ditch, Rocky Creek, Phinizy Ditch, and Beaverdam Ditch, which eventually flow into Butler Creek, receive untreated and inadequately treated municipal and industrial wastes (Table 3). Water quality at some locations qualified them as open sewers. For example, $BOD_5$ in Camille Ditch was 215 mg/l, dissolved oxygen zero, and the mean fecal coliform bacteria density 29,000,000/100 ml. The upstream section of Beaverdam Ditch containing wastes draining from the Industrial Canal, has undetectable dissolved oxygen, 173 mg/l of BOD, and a mean fecal coliform bacteria density greater than 9,300,000/100 ml. Oates Creek and Rocky Creek, while less grossly contaminated, exhibit excessive pollution from untreated waste sources.

Butler Creek, upstream of known waste sources and polluted tributary inflow, has a dissolved oxygen of 8.3 mg/l, BOD of 1.2 mg/l, and a mean fecal coliform density of 600/100 ml. However, pathogenic Salmonella were isolated at the location, indicating an unknown source of waste. Butler Creek also receives, via Phinizy Ditch, the effluent from the City of Augusta's primary sewage treatment plant. During the survey, the plant was treating 8 million gallons per day of wastes. This represents about 30 percent of the total water supply for the Augusta area, indicating that approximately 14 MGD that normally ends up as wastewater either receives no treatment or the status of the treatment is unknown. Since the Augusta plant does not provide adequate treatment, it is reasonable to conclude that none of the wastes discharged to the Augusta, Georgia, sewerage treatment system receives satisfactory treatment.

### Table 3
### WATER QUALITY SUMMARY
### AUGUSTA, GEORGIA INDUSTRIAL CANAL & TRIBUTARIES

| Station | IC-1 | IC-2 | SL-3 | RC-12 | LC-13 | HG-4 |
|---|---|---|---|---|---|---|
| DO (mg/l) | 6.7 | 7.0 | 7.3 | 6.4 | 8.4 | 8.6 |
| Temp (°C) | 11.8 | 11.8 | 11.9 | 22.0 | 21.8 | 15.1 |
| DO (% Sat) | 61 | 64 | 67 | 72 | 94 | 85 |
| pH | 6.5 | 6.3 | 6.5 | 6.8 | 6.8 | 6.7 |
| Alkalinity (mg/l) | 14 | 14 | 14 | 24 | 18 | 16 |
| $BOD_5$ (mg/l) | 0.8 | 0.7 | 0.6 | 1.8 | 2.25 | 2.6 |
| Color (pt-Co U) | 27 | - | - | - | - | 31 |
| Turbidity (JTU) | 16 | 16 | 18 | 9.5 | 14 | 18.5 |
| TOC (mg/l) | 4 | 5 | 4 | 5.5 | 7 | 5.25 |
| COD (mg/l) | - | - | 6.0 | 8.0 | 16 | 6.7 |
| TKN-N (mg/l) | .40 | .11 | .40 | .30 | .31 | .57 |
| $NH_3$-N (mg/l) | .045 | .04 | .03 | .10 | .085 | .40 |
| $NO_3$-$NO_2$-N (mg/l) | .24 | .23 | .22 | .07 | < .01 | .195 |
| Phosphate-P (mg/l) | .01 | .02 | .018 | .025 | .035 | .07 |
| Ortho-P (mg/l) | .01 | .01 | .01 | .02 | .015 | .03 |
| Solids, N-FS (mg/l) | 7.5 | 7.0 | 12.5 | 11 | 20 | 10 |
| Solids, VN-FS (mg/l) | 2.0 | - | 3 | 3 | 10 | 4.2 |
| Cr. water (mg/l) | 0.06 | - | - | - | - | .03 |
| Cr. sediment (mg/kg) | - | - | - | - | - | - |
| Flow (mgd) | - | - | - | 0.5 | - | 503 |

- Denotes Parameter not determined.


SAVANNAH RIVER
1
Industrial
2
Canal
3
4
Hawks Gully
Reed Cr.
12
13
Lake Olmstead
Cranes Cr.
Raes Cr.

The Augusta sewage treatment plant is designed for a flow of 23 MGD. Both domestic and industrial wastes are received including slaughterhouse, chemical and textile effluents. Pretreatment of industrial waste is not required. An in-plant survey by the Georgia Water Quality Control Board showed $BOD_5$ and suspended solids removal to be 37 and 38 percent respectively during the EPA study. According to plant records from May through December 1970, the average removal efficiency was 27.9 percent and 45.5 percent respectively for $BOD_5$ and suspended solids. However, the average removal efficiency during July 1970, the time of the water quality study, was 5.8 percent for $BOD_5$. Effluent $BOD_5$ measured during the survey was 8,470 pounds per day, equivalent to a human population of 50,800. The suspended solids effluent was 4,740 pounds per day.

Butler Creek, at the confluence with the Savannah River, was grossly polluted by untreated and inadequately treated municipal and industrial wastes from Augusta, Georgia. The substrate in this reach of the creek was covered with active sludge deposits of decomposing sludge containing 3.9 percent carbon and 81 mg/kg chromium (Appendix C). The average dissolved oxygen was 0.5 mg/l, $BOD_5$ 47.9 mg/l, and average fecal coliform bacteria density 5,900,000/100 ml. Salmonella were recovered at this location. Water quality of Butler Creek and its tributaries is described in Table 4.

Olin Mathieson Corporation discharges approximately 2.5 MGD of waste to the Savannah River and, until May 1970, was the major source of mercury contamination in the Middle Savannah River. At that time, Olin was discharging approximately 12 pounds per day of mercury. Weekly average mercury discharges from October 25 to December 27, 1970 ranged between 0.074 pounds per day and 0.506 pounds per day; on June 15, 1971, EPA results showed a discharge of 0.04 pounds per day.

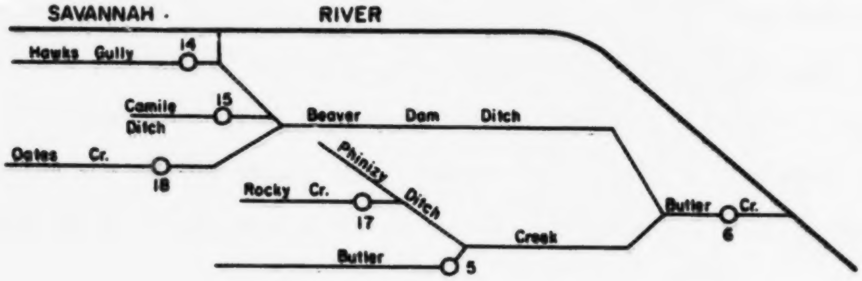
Spirit Creek is polluted by effluents from the Fort Gordon sewage treatment plant and grossly polluted by the discharge from the Continental Can-Cox Newsprint wastewater holding ponds.

Table 4

WATER QUALITY SUMMARY
BUTLER CREEK AND TRIBUTARIES

| Station | BC-5 | BC-6 | U-15 | OC-16 | RC-17 | G-14 |
|---|---|---|---|---|---|---|
| DO (mg/l) | 8.3 | .6 | 0 | 4.0 | 1.4 | 0 |
| Temp (°C) | 16.8 | 21.8 | 22.5 | 19.0 | 20.0 | 22.3 |
| DO (% Sat) | 84 | 6 | 0 | 42.5 | 15 | 0 |
| pH | 6.8 | 6.7 | 6.6 | 6.8 | 6.2 | 6.8 |
| Alkalinity (mg/l) | 12 | 60 | 101 | 24 | 16 | 99 |
| $BOD_5$ (mg/l) | 1.2 | 47.9 | 215 | 7.2 | 13.5 | 173 |
| Color (pt-Co U) | - | - | - | - | - | - |
| Turbidity (JTU) | 17 | 40 | 70 | 19 | 45 | 39 |
| TOC (mg/l) | 8 | 27 | 67 | 7.5 | 11.5 | 40.5 |
| COD (mg/l) | 9.4 | 97 | 430 | 16 | 15 | 130 |
| TKN-N (mg/l) | .20 | 9.2 | 16.4 | 1.2 | 1.0 | 12.0 |
| $NH_3$-N (mg/l) | .03 | 8.4 | 14.5 | .7 | .28 | 9.8 |
| $NO_3$-$NO_2$-N (mg/l) | .17 | .13 | .05 | .22 | .18 | .02 |
| Phosphorus-P (mg/L) | .66 | 5.8 | 10.7 | .87 | .12 | 28 |
| Ortho-P (mg/l) | .59 | 4.88 | 9.5 | .76 | .10 | 7.2 |
| Solids, N-FS (mg/l) | 22 | 43 | 196 | 43 | 40 | 60 |
| Solids, Volatile N-FS (mg/l) | 7 | 21 | 150 | 23 | 10 | 42 |
| Cr. water (mg/l) | - | - | - | - | - | - |
| Cr. Sediment (mg/kg) | 7 | 81 | - | - | - | - |
| Flow (mgd) | - | 54.4 | 5.55 | 3.38 | 3.44 | 5.1 |

- Denotes Parameter not determined.


SAVANNAH · RIVER
Hawks Gully
14
Camile Ditch
15
Beaver Dam Ditch
Oates Cr.
18
Phinizy Ditch
Rocky Cr.
17
Creek
Butler
5
Butler Cr.
6

Fort Gordon discharges approximately 1.7 MGD from a secondary plant which had an average removal efficiency during 1970 of 91 percent for $BOD_5$ and 88 percent for suspended solids. The effluent is not chlorinated, and the average fecal coliform bacteria density is 1,600,000/100 ml. Salmonella were isolated in the effluent.

Water quality in Spirit Creek below the Fort Gordon sewage treatment plant outfall showed an average dissolved oxygen of 3.9 mg/l, $BOD_5$ of 5.5 mg/l, and elevated nutrient levels (Table 5). Spirit Creek, upstream of the Continental Can-Cox Newsprint waste discharge and approximately 17 miles downstream from the Fort Gordon effluent, exhibited concentrations of fecal coliform bacteria averaging 1,500/100 ml. Salmonella were observed at this location. Dissolved oxygen was 7.2 mg/l, $BOD_5$ 2.8 mg/l, and color 58 units. This reach of the stream supported flora and fauna representative of a healthy environment.

Continental Can-Cox Newsprint discharges approximately 37 MGD to Spirit Creek about one-half mile upstream of the confluence with the Savannah River. The waste receives primary settling and detention in five holding ponds, two of which are aerated. The sludge is pumped to a separate holding pond, and the supernatant from the sludge lagoon is discharged to Spirit Creek. According to Georgia Water Quality Control Board data collected during July 1970, the $BOD_5$ removal efficiency in the holding ponds was about 73 percent. The discharge to Spirit Creek was 11,260 pounds and 26,270 pounds per day of $BOD_5$ and suspended solids respectively.

Dissolved oxygen in Spirit Creek downstream of the discharge average 0.1 mg/l, $BOD_5$ 22 mg/l, and 472 color units. The average fecal coliform density was 1,100/100 ml, and Salmonella was recovered. Concentrations of organic carbon, organic nitrogen, and total phosphorus increased ten times in the bottom sediments downstream of the waste discharge. Only very tolerant forms of aquatic life were found in this reach of the creek, and from a biological point of view, the creek is "grossly" polluted. A water quality summary in Spirit Creek is presented in Table 5.

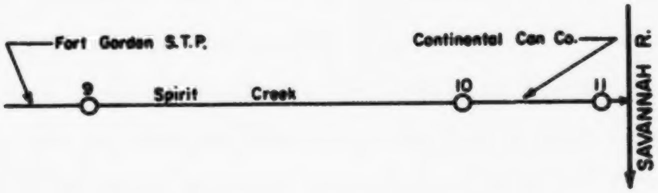
Water quality criteria have not been established for tributary streams in Georgia.

## TABLE 5

## WATER QUALITY SUMMARY
## SPIRIT CREEK

| Station | SC-9 | SC-10 | SC-11 |
|---|---|---|---|
| DO (mg/l) | 3.9 | 7. 2 | 0.09 |
| Temp. (°C) | 18.8 | 19.8 | 23.4 |
| DO (% Sat) | 41 | 78 | 1 |
| pH | 6.4 | 6.4 | 7.1 |
| Alkalinity (mg/l) | 12.7 | 8 | 100 |
| BOD$_5$ (mg/l) | 5.5 | 2.8 | 22 |
| Color (pt-Co U) | - | 57.5 | 472 |
| Turbidity (JTU) | 12.4 | 12.4 | 24.3 |
| TOC (mg/l) | 7 | 6.4 | 60.3 |
| COD (mg/l) | 23 | 12.5 | 160 |
| TKN-N (mg/l) | 1.51 | 0.46 | 2.04 |
| NH$_3$-N (mg/l) | 0.98 | 0.11 | 0.41 |
| NO$_3$-NO$_2$-N (mg/l) | 2.04 | 0.31 | 0.016 |
| Phosphorus-P (mg/l) | 1.65 | 0.50 | 0.51 |
| Ortho-P (mg/l) | 1.46 | 0.43 | 0.36 |
| Solids, N-FS (mg/l) | 12.5 | 20 | 48.5 |
| Solids, VN-FS (mg/l) | 5.5 | 4 | 31 |
| Cr. Water (mg/l) | - | 0.16 | 1.95 |
| Cr. Sediment (mg/kg) | - | 0.01 | 0.09 |
| Flow (mgd) | - | 28.0 | 65.5 |

- Denotes Parameter not determined.


Fort Gordon S.T.P.
Continental Can Co.
9
Spirit
Creek
10
11
SAVANNAH R.

## South Carolina Waste Sources and Tributary Streams

Twelve waste sources discharging either directly or indirectly to the Savannah River were sampled in South Carolina. A summary of waste loadings from these sources is contained in Table 6.

The City of North Augusta, South Carolina, does not have sewage treatment facilities. Approximately 0.95 MGD are discharged raw to the Savannah River just downstream of the 13th Street bridge. The average daily discharge contains 842 pounds of $BOD_5$, 887 pounds of solids, and a mean fecal coliform bacteria density of 24,000,000/100 ml. Salmonella were isolated in the effluent. The South Carolina Pollution Control Authority is requiring North Augusta to have an acceptable secondary sewage treatment plant in operation by April 15, 1972.

Horse Creek and its tributary, Little Horse Creek, are completely degraded due to the discharge of more than 11 MGD of untreated textile mill wastes and an unquantified amount of domestic waste which drains directly to Horse Creek due to the lack of an interceptor system. South Carolina has classified these streams for propagation of fish, agricultural, and industrial uses which in area other than swamp areas require a dissolved oxygen greater than 4 mg/l and pH between the range of 6.0 and 8.5. Water quality in Horse Creek is shown in Table 7. Except for two points, one upstream of waste sources and one below a spillway, dissolved oxygen averaged about 1 mg/l and pH ranged between 9.3 and 11.6. The high pH is caused by the alkaline textile waste discharges. Fecal coliform bacteria densities averaged greater than 20,000/100 ml. Color increased from 41 units to 74 units and suspended solids from 6 mg/l to 82 mg/l. Just upstream of the confluence with the Savannah River, chromium concentration in the waters of Horse Creek was 0.44 mg/l; however, bottom sediments contain 990 mg/kg which is toxic to bottom organisms and destroys fish and spawning areas. Approximately 305 pounds per day of chromium flows into the Savannah River from Horse Creek.

The City of Aiken, South Carolina, operates a trickling filter plant discharging 0.95 MGD to Kelly Creek, approximately 2.8 miles upstream from the

TABLE 6

AVERAGE WASTE LOADINGS (LBS/DAY)
SOUTH CAROLINA SOURCES

| Source or Tributary | Receiving Stream | Dis-charge (mgd) | $BOD_5$ | TOC | COD | Nitrogenous Compounds (P) | | | Phosphorus (P) | | Solids | | Metals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TKN | $NH_3$ | $NO_2$-$NO_3$ | Total | Ortho-P | N-FS | VN-FS | Cr | Hg |
| N.Aug.Sewer Outfall | Savannah R. | 0.95 | 842 | 293 | 1,420 | 105 | - | 1.03 | 58.6 | 57.0 | 887 | 697 | - | - |
| Aiken STP | Kelly Cr. | 0.93 | 240 | 256 | 931 | 157 | 153 | 7.36 | 101 | 96.9 | 202 | 140 | - | - |
| Warrenville STP | Kelly Cr. | 0.33 | 105 | 66 | 220 | 50.4 | 50.4 | 0.027 | 30 | 13.8 | 110 | 99.1 | 0.23 | - |
| Clearwater Fin.Pl. | Little Hrs. Cr. | 4.52 | 24,200 | 8,710 | 28,800 | 459 | 104 | 11.3 | 38.4 | 32.0 | 5,840 | 5,180 | 7.54 | - |
| Seminole Mill | Little Hrs. Cr. | 0.04 | 26 | 7 | 17 | 0.27 | 0.06 | 0.025 | 0.83 | 0.76 | 7.4 | 4.0 | < .01 | - |
| Graniteville Mill | Horse Creek | 4.65 | 30,060 | 13,650 | 46,000 | 244 | 6.20 | 20.6 | 95.80 | 71.0 | 6,200 | 5,350 | 865 | - |
| Valchem Ch. Co. | Horse Creek | 1.61 | 363 | 349 | 1,950 | 3,810 | 3650 | 129 | 5.9 | 3.5 | 362.5 | 228.3 | 11.8 | - |
| Bath Mill | Horse Creek | 0.303 | 243 | 246 | 354 | 4.3 | 0.43 | 1.5 | 1.33 | 0.96 | 10.1 | 5.0 | 0.08 | - |
| Horse Creek | Savannah R. | 83.3 | 23,200 | 12,290 | 40,600 | 1,210 | 318 | 13.5 | 271 | 107 | 50,260 | 12,300 | 306 | - |
| Kimberly-Clark | Savannah R. | 6.89 | 454 | 383 | 862 | 28.7 | 6.3 | 2.9 | 1.1 | 0.57 | 575 | 402 | - | - |
| J.P.Stevens Company | Lower Three Runs Cr. | 0.38 | 7,240 | 4,750 | 23.8 | 215 | 93.8 | 0.3 | 5.7 | 4.21 | 7,920 | 6,180 | 0.10 | - |
| Lower Three Runs Cr. | Savannah R. | 27.8 | 3,990 | 3,660 | 10,100 | 293 | 138 | 18 | 14 | 12.5 | 3,250 | 1,970 | - | - |

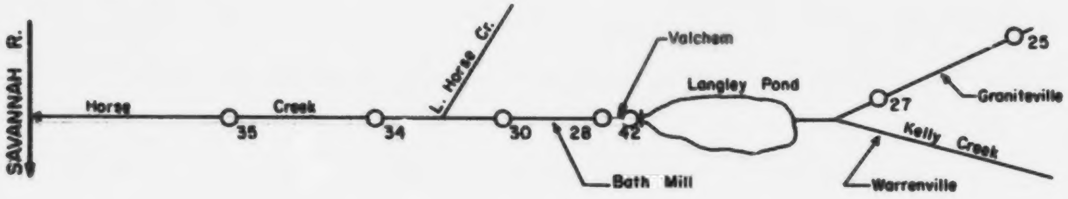
- Denotes determination not made.

## TABLE 7

## WATER QUALITY SUMMARY
## HORSE CREEK

| Station | HC-25 | HC-27 | LP-42 | HC-29 | HC-30 | HC-34 | HC-35 |
|---|---|---|---|---|---|---|---|
| DO (mg/l) | 7.2 | 0.8 | 0.0 | 5.2 | 1.3 | 0.9 | 1.6 |
| Temp. ($^{o}$C) | 25.5 | 28.2 | 28.0 | 27.8 | 27.9 | 28.8 | 28.0 |
| DO (% Sat) | 86 | 10 | - | 65 | 16 | 11 | 20 |
| pH | 6.1 | 11.6 | 9.6 | 9.8 | 9.5 | 9.4 | 9.3 |
| Alkalinity (mg/l) | 4 | 335 | 120 | 153 | 134 | 118 | 94 |
| BOD$_5$ | 1.0 | 122 | 15 | 15.5 | 19 | 42 | 28.4 |
| Color (pt-Co U) | 41 | 165 | - | - | 81 | - | 74.4 |
| Turbidity (JTU) | 7 | 14 | 16 | 17 | 15.4 | 26 | 46.4 |
| TOC (mg/l) | 4 | 75 | 16 | 18 | 22 | 21 | 16.9 |
| COD (mg/l) | < 5 | 200 | 45 | 72 | 43.5 | 94 | 62.3 |
| TKN-N (mg/l) | 0.15 | 1.63 | 0.82 | 7.9 | 5.36 | 5.58 | 1.50 |
| $NH_3$-N (mg/l) | 0.05 | 0.04 | 0.07 | 6.78 | 4.07 | 3.99 | 0.35 |
| $NO_3$-$NO_2$-N (mg/l) | 0.05 | 0.09 | < 0.01 | 0.01 | 0.03 | 0.04 | 0.02 |
| Phosphorus-P (mg/l) | 0.01 | 0.47 | 0.375 | 0.49 | 0.37 | 0.60 | 0.37 |
| Ortho-P (mg/l) | 0.01 | 0.29 | 0.245 | 0.29 | 0.24 | 0.28 | 0.15 |
| Solids, N-FS (mg/l) | 6 | 27.5 | 19.5 | 15.5 | 17 | 33 | 82 |
| Solids, VN-FS (mg/l) | 5 | 20.5 | 14 | 9 | 11.5 | 17 | 19.7 |
| Cr. Water | - | - | - | - | - | - | 0.44 |
| Cr. Sediment | - | - | - | - | - | - | 990 |
| Flow (mgd) | - | 41.3 | 41.3 | - | 69.8 | 83.1 | 83.3 |

- Denotes Parameter not determined.


SAVANNAH R.
Horse
Creek
35
34
L. Horse Cr.
30
28
42
Bath Mill
Valchem
Langley Pond
27
25
Graniteville
Kelly Creek
Warrenville

confluence with Horse Creek. The plant discharges 240 pounds per day of $BOD_5$ and 202 pounds per day of suspended solids. Chlorination was not employed during the survey due to equipment failure. Salmonella were isolated from the effluent, and the mean fecal coliform bacteria density in the effluent was 7,500,000/100 ml.

The Warrenville sewage treatment plant, an antiquated facility on Kelly Creek just above the confluence with Horse Creek, is owned by the Graniteville Textile Company and treats 0.33 MGD of wastes from the towns of Warrenville and Graniteville and the Vancluse Mill of Graniteville Textile Company. No chlorination is applied, and the mean fecal coliform bacteria density observed in the effluent was 8,200,000/100 ml. Salmonella were isolated in the effluent which contained 104 pounds per day of $BOD_5$ and 110 pounds per day of suspended solids. A water quality summary of Kelly Creek is contained in Table 8.

The Graniteville Textile Company's Gregg Mill discharges 4.65 MGD of untreated finishing plant waste into Horse Creek. This waste contains 30,100 pounds per day of $BOD_5$ equivalent to a population of nearly 181,000, 6,200 pounds per day of suspended solids, and 865 pounds per day of chromium. This waste discharge is the major source of toxic chromium to Horse Creek and the Savannah River. Abatement facilities, consisting of aerated lagoons, were scheduled to be in operation by December 1970, and according to information obtained from the South Carolina Pollution Control Authority these facilities are in operation. The Company estimates a $BOD_5$ removal of 85 percent in the lagoons.

Bath Mill, a subsidiary of United Merchants and Manufacturing, Inc. discharges 300,000 gallons per day of untreated domestic and industrial waste containing 240 pounds per day of $BOD_5$ to Horse Creek approximately 4.6 miles upstream from the confluence with the Savannah River.

Valchem Chemical Company, also a subsidiary of United Merchants and Manufacturing, Inc., discharges 1.6 MGD of domestic, industrial wastes and cooling water to Horse Creek about 6.6 miles upstream from the Savannah River.

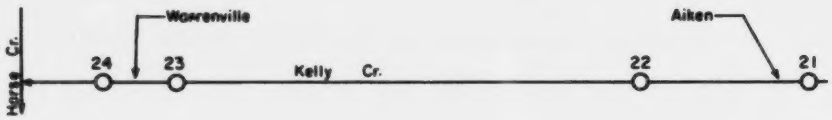
## TABLE 8

## WATER QUALITY SUMMARY

## KELLY CREEK

| Station | KC-21 | KC-22 | KC-23 | KC-24 |
|---|---|---|---|---|
| DO (mg/l) | 8.5 | 5.3 | 5.5 | 7.8 |
| Temp. (°C) | 18.3 | 18.9 | 22.1 | 21.0 |
| DO (% Sat) | 89 | 56 | 62 | 86 |
| pH | 6.0 | 6.2 | 6.2 | 6.3 |
| Alkalinity (mg/l) | 3 | 7 | 6 | 8 |
| $BOD_5$ (mg/l) | 0.7 | 1.9 | 1.2 | 1.9 |
| Color (Pt-Co U) | 16 | - | - | 23 |
| Turbidity (JTU) | 13 | 16.4 | 13.8 | 12.4 |
| TOC (mg/l | 4.7 | 5.2 | 6 | 5.6 |
| COD (mg/l) | $< 5$ | 7.7 | 6.0 | 13.3 |
| TKN-N (mg/l) | 0.15 | 0.41 | 0.32 | 0.54 |
| $NH_3$-N (mg/l) | 0.05 | 0.19 | 0.12 | 0.37 |
| $NO_3$-$NO_2$-N (mg/l) | 0.33 | 0.94 | 0.97 | 0.99 |
| Phosphorus-P (mg/l) 0.0 | 0.015 | 0.81 | 0.74 | 0.81 |
| Ortho-P (mg/l) 0.01 | 0.[illegible]5 | 0.76 | 0.74 | 0.78 |
| Solids, N-FS (mg/l) | 10.5 | 19.5 | 10 | 12 |
| Solids, VN-FS (mg/l) | 7 | 7.5 | 5 | 7 |
| Flow (mgd) | - | - | - | 17.44 |

- Denotes Parameter not determined.



The Valchem plant waste contained substances which interfered with $BOD_5$ determinations; however, plant records indicate a daily discharge of 360 pounds of $BOD_5$. The wastes also contained 3,650 pounds per day of ammonia nitrogen and 12 pounds per day of chromium.

The Clearwater Finishing Plant of United Merchants and Manufacturing, Inc. discharges daily 4.5 MG of untreated domestic and industrial wastes containing 24,200 pounds of $BOD_5$ which is equivalent to a human population of 145,000. This waste also contains 5,800 pounds per day of suspended solids and 7.5 pounds per day of chromium. The discharge is to Little Horse Creek about 0.3 mile above the confluence with Horse Creek.

Seminole Mill, a subsidiary of United Merchants and Manufacturing, Inc. discharges to Horse Creek downstream from the Clearwater Finishing Plant approximately 0.4 MGD of untreated boiler blowdown water, air conditioning wastewater, and a small amount of domestic wastes.

Based on substrate, chemical and biological changes, discharges from the Clearwater Finishing Plant and Seminole Mill severely degrade water quality in Little Horse Creek (Table 9 and Appendix C). Conditions upstream and downstream of these discharges undergo considerable change -- substrate changes from a cleanly washed sandy, gravel and silt to an active decomposing sludge deposit laden with 163 mg/kg of chromium; background $BOD_5$ increases from 1.4 mg/l to 173 mg/l, and flora and fauna change from inhabitants indicative of a clean water environment to those representative of a grossly polluted one.

Although more than 55,000 pounds per day of $BOD_5$ is discharged from waste sources on Horse Creek and its tributaries, only 42 percent or 23,200 pounds per day of this waste was observed at the confluence with the Savannah River.

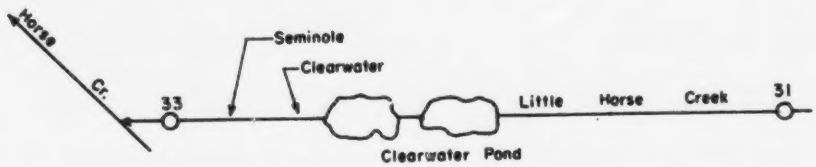
Kimberly Clark Paper Company discharges 6.9 MGD of domestic and industrial waste to a lagoon system with 40 days detention and no disinfection. The daily effluent contained 450 pounds of $BOD_5$, 575 pounds of suspended solids, and

## TABLE 9

## WATER QUALITY SUMMARY
## LITTLE HORSE CREEK

| Station | LHC-31 | LHC-33 |
|---|---|---|
| DO (mg/l | 8.1 | 6.15 |
| Temp (°C) | 24.4 | 29.5 |
| DO (% Sat) | 95 | 79 |
| pH | 6.5 | 10.3 |
| Alkalinity (mg/l) | 4 | 64 |
| BOD$_5$ (mg/l) | 1.4 | 173 |
| Color (Pt-Co U) | 66 | 175 |
| Turbidity (JTU) | 18.2 | 70 |
| TOC (mg/l) | 5.4 | 43.2 |
| COD (mg/l) | 8.9 | 175 |
| TKN-N (mg/l) | 0.31 | 2.98 |
| NH$_3$-N (mg/l) | 0.05 | 0.27 |
| NO$_3$-NO$_2$-N (mg/l) | 0.11 | 0.10 |
| Phosphorus-P (mg/l) | 0.05 | 0.76 |
| Ortho-P (mg/l) | 0.04 | 0.36 |
| Solids, N-FS (mg/l) | 17.5 | 58 |
| Solids, VN-FS (mg/l) | 11 | 57 |
| Cr. Sediment (mg/l) | 10 | 163 |
| Flow (mgd) | - | 13.3 |

NOTE "-" Denotes Parameter Not Determined.


Horse Cr.
Seminole
Clearwater
33
Little Horse Creek
31
Clearwater Pond

a mean fecal coliform bacteria density of 170/100 ml. The effluent goes directly to the Savannah River through Dead River which consists entirely of waste flow.

The J. P. Stevens Company wool scouring mill in Allendale County, South Carolina, discharges 0.38 MGD of untreated domestic and industrial waste to Davis Branch, a tributary to Lower Three Runs Creek approximately six miles above the creek's confluence with the Savannah River. The daily discharge contains 7,200 pounds of $BOD_5$ and 7,900 pounds of suspended solids. Although water quality in Davis Branch was not tested, data from three Lower Three Runs Creek sampling stations located above and below the confluence of Davis Branch did show noticeable water quality degradation. The 7.3 mg/l of dissolved oxygen observed at the upstream station was suppressed to 2.2 mg/l by the discharge from Davis Branch. The 1.0 mg/l of $BOD_5$ observed at the upstream station increased to 17.2 mg/l at the station immediately below the confluence of Davis Branch (Table 10). Biological observations also reflect a similar change (Appendix C). The upstream station supported a diverse community of macroinvertebrates which are indicative of a clean water stream while inhabitants of the reach of the creek downstream of the mill discharge indicate a polluted environment. Although the mean fecal coliform bacteria density was 9,100,000/100 ml, Salmonella were not detected in the waste effluent or in Lower Three Runs Creek.

The Company has submitted plans to the South Carolina Pollution Control Authority for abatement facilities.

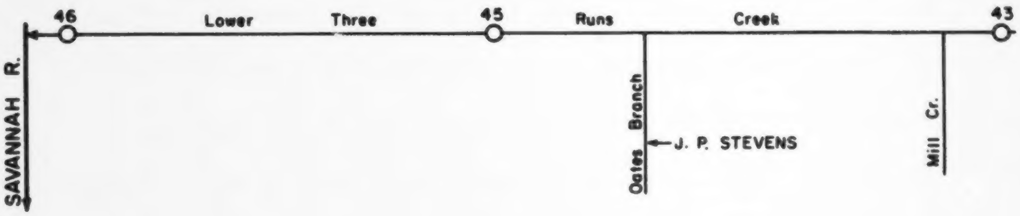
The Savannah River Plant is owned by the Atomic Energy Commission and operated by DuPont. Its primary function is to manufacture materials for national defense; however, other materials are also produced. Waste treatment

## TABLE 10

## WATER QUALITY SUMMARY
## LOWER THREE RUNS CREEK

| Station | LTR-43 | LTR-45 | LTR-46 |
|---|---|---|---|
| DO (mg/1) | 7.3 | 3.3 | 2.5 |
| Temp. (°C) | 25.3 | 25.3 | 24.2 |
| % Sat. | 87 | 39 | 29 |
| pH | 7.3 | 7.1 | 7.0 |
| Alk. (mg/1) | 44 | 50 | 51 |
| $BOD_5$ (mg/1) | 1.0 | 17.2 | 4.28 |
| Color (Pt-Co U) | 22 | - | - |
| Turbidity (JTU) | 4 | 16.4 | 5.8 |
| TOC (mg/1) | 3 | 15.8 | 7.2 |
| COD (mg/1) | 7.45 | 43.5 | 15.5 |
| TKN-N (mg/1) | .19 | 0.83 | .54 |
| $NH_3$-N (mg/1) | .16 | .60 | .25 |
| $NO_2$-$NO_3$-N (mg/1) | .11 | .08 | .046 |
| Total-P (mg/1) | .03 | .06 | .05 |
| Ortho-P (mg/1) | .03 | .05 | .05 |
| Solids, N-FS (mg/1) | 4 | 14 | 4.5 |
| Solids, VN-FS (mg/1) | - | 8.5 | 2.5 |
| Chromium (mg/1) | 0.03 | - | 0.3 |
| Flow (mgd) | - | 27.8 | - |

NOTE - "-" Denotes Parameter Not Determined.


46
Lower
Three
45
Runs
Creek
43
SAVANNAH R.
Oates Branch
J. P. STEVENS
Mill Cr.

facilities consisting of primary facilities, waste ponds and septic tanks, should be upgraded to secondary facilities consistent with Executive Order No. 11507.

The examination of water quality of streams within the AEC Savannah River Plant during October 1970 indicated no appreciable water quality degradation (Figure 3). Water quality in the tributaries had no noticeable effect on the Savannah River. Steel Creek showed the greatest variation in $BOD_5$ (0.4 mg/l-7.8 mg/l) with an average $BOD_5$ of 2.5 mg/l (Table 11). Elevated temperatures were observed at the mouth of Four Mile Creek but did not alter temperatures in the Savannah River. Mean fecal coliform bacteria density in the tributaries did indicate fecal contamination and Salmonella were found at eight stations. Sample results also showed a small increase in the nutrient content of all streams within the plant area with total phosphorus concentrations in Four Mile Creek and Pen Branch approaching levels at which biological nuisances could occur.

## Savannah River Water Quality

If all of the waste bearing sources and tributaries flowing into the Savannah River in the Augusta metropolitan area, excluding Hawks Gully, were introduced at one location, the dilution, on a flow basis, would be about 20 to 1 at low weekend flows. With Hawks Gully included, the dilution is still about 6 to 1. When waste sources only are included, the diultion is 60 to 1. Dilution is the primary reason the chemical parameters did not generally indicate appreciable degradation of the Savannah River by waste discharges. The mean dissolved oxygen at all locations in the Savannah River was greater than 6.7 mg/l, and the minimum value observed was 4.4 mg/l (Table 12, Figure 4). However, dissolved oxygen collected from the Savannah

## TABLE 11
## WATER QUALITY SUMMARY
## ATOMIC ENERGY COMMISSION
## SAVANNAH RIVER PLANT

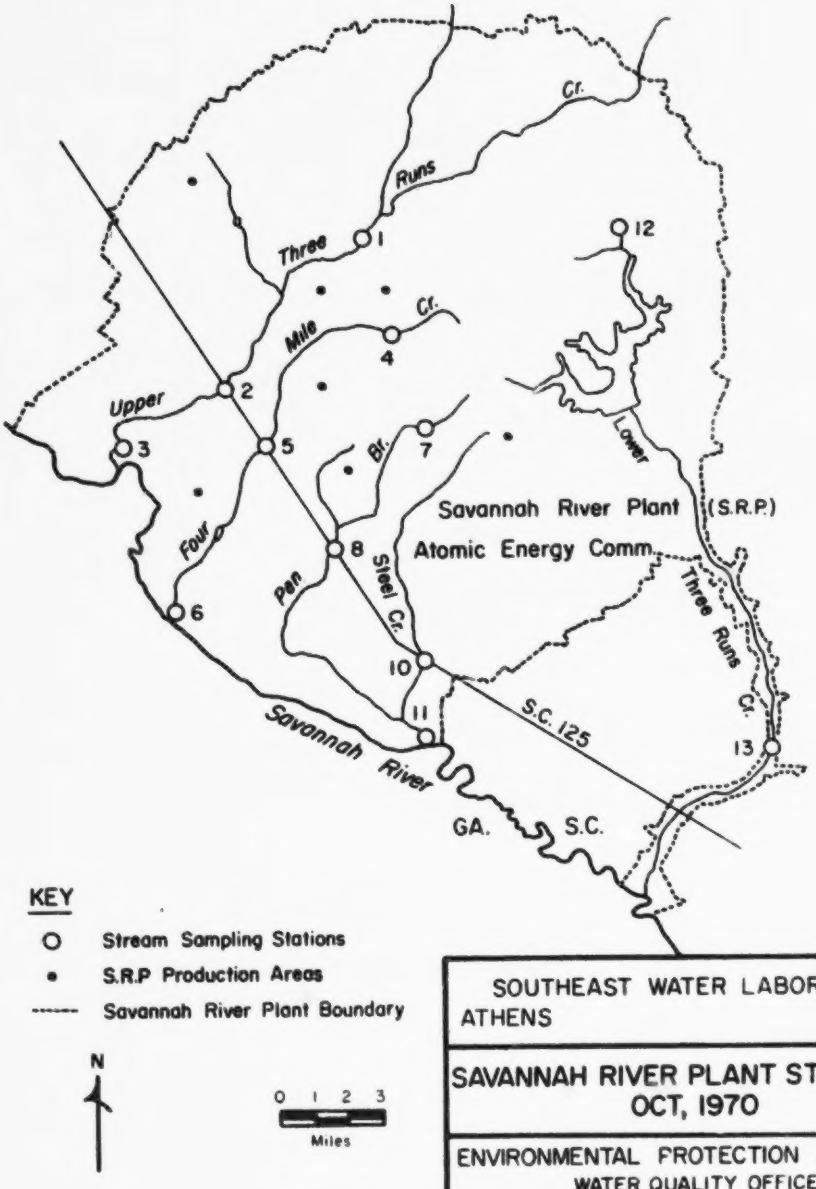
| Station | Temp °C | DO mg/1 | DO % Sat | $BOD_5$ mg/1 | TOC mg/1 | pH | Alk. mg/1 | Turb. JTU | TKN-N mg/1 | $NH_3$-N mg/1 | $NO_2$-$NO_3$-N mg/1 | Total-P mg/1 | Ortho-P mg/1 | Fecal Colif MPN/ 100 ml | *Salmonella* Sero-type Detected |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UTR-1 | 16 | 8.1 | 81 | 1.4 | 6 | 6.1 | 4 | 1 | 0.27 | 0.04 | 0.16 | 0.04 | 0.01 | 410 | *S. litchfield* |
| UTR-2 | 16 | 8.4 | 85 | 1.4 | 7 | 6.2 | 5 | 3 | 0.24 | 0.10 | 0.17 | 0.04 | 0.02 | 270 | *S. litchfield* |
| UTR-3 | 15 | 8.4 | 82 | 1.7 | 8 | 6.1 | 5 | 2 | 0.52 | 0.27 | 0.21 | 0.03 | 0.02 | 550 | *S. oranienburg* |
| FMC-4 | 16 | 7.6 | 76 | 1.3 | 8 | 6.0 | 7 | 2 | 0.33 | 0.10 | 0.30 | 0.03 | 0.01 | 940 | *S. frankfort* |
| FMC-5 | -- | 6.3 | -- | 1.1 | 3 | 6.7 | 15 | 3 | 0.26 | 0.11 | 0.38 | 0.09 | 0.06 | 48 | None |
| FMC-6 | 29 | 5.9 | 77 | 1.5 | 3 | 6.5 | 16 | 3 | 0.29 | 0.10 | 0.46 | 0.10 | 0.08 | 220 | *S. litchfield* |
| PB-7 | 16 | 8.0 | 80 | 1.0 | 9 | 6.7 | 19 | 2 | 0.36 | 0.04 | 0.06 | 0.05 | 0.02 | 760 | *S. rubislaw* |
| PB-8 | -- | 7.1 | -- | 1.1 | 4 | 6.7 | 17 | 3 | 0.44 | 0.24 | 0.38 | 0.10 | 0.07 | 5900 | Sample Lost |
| ST-10 | 18.5 | 8.8 | 93 | 2.5 | 5 | 6.7 | 22 | 1 | 0.20 | 0.04 | 0.07 | 0.02 | 0.01 | 430 | None |
| ST-11 | 18 | 6.8 | 72 | 1.0 | 4 | 6.5 | 18 | 1 | 0.27 | 0.17 | 0.04 | 0.04 | 0.02 | 85 | *S. oranienburg* |
| LTR-12 | 17 | 7.6 | 77 | 1.2 | 6 | 6.5 | 16 | 2 | 0.29 | 0.22 | 0.18 | 0.02 | 0.01 | 300 | *S. rubislaw* |
| LTR-13 | 17 | 7.9 | 80 | 1.1 | 6 | 6.6 | 30 | <1 | 0.22 | 0.06 | 0.02 | 0.05 | 0.04 | 96 | None |

NOTE: Values shown are arithmetic means except for fecal coliform which is geometric

TABLE 17
WATER QUALITY SUMMARY
AVERAGE VALUES FOR THE MIDDLE REACH OF THE
SAVANNAH RIVER
JULY-AUGUST 1970

| Station No. | River Mile | Temp (°C) | Dissolved Oxygen |  | pH | Alkalinity (mg/l) | Turbidity (JTU) | Color (Pt-Co U) | BOD (mg/l) | COD (mg/l) | TOC (mg/l) | Nitrogenous Compounds N(mg/l) |  |  | Phosphorus-P (mg/l) |  | Solids (mg/l) |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | (mg/l) | Sat % |  |  |  |  |  |  |  | TKN | $NH_3$ | $NO_2$-$NO_3$ | Total | Ortho | N-FS | VN-FS |
| S50 | 207.60 | 21.2 | 5.9 | 65 | 6.7 | 14 | 22 | 47 | 2.8 | 9.6 | 5.0 | 0.21 | 0.10 | 0.17 | 0.03 | 0.03 | 5.0 | <1.0 |
| S51-R | 200.73 | 18.8 | 8.4 | 89 | 6.7 | 15 | 11 | 16 | 1.3 | 7.7 | 3.7 | 0.65 | 0.14 | 0.19 | 0.03 | 0.03 | 4.0 | 1.0 |
| S51-C | 200.73 | — | — | — | — | — | 8 | 17 | — | — | — | — | — | — | — | — | 4.5 | 1.5 |
| S51-L | 200.73 | 19.3 | 8.8 | 94 | 6.7 | 14 | 13 | 13 | 1.1 | <5.0 | 3.3 | 0.30 | 0.12 | 0.18 | 0.03 | 0.03 | 5.2 | 2.0 |
| S52-R | 199.62 | 19.0 | 8.5 | 90 | 6.7 | 14 | 15 | — | 0.9 | <5.0 | 3.7 | 0.11 | 0.05 | 0.18 | 0.03 | 0.02 | 2.0 | <1.0 |
| S52-C | 199.62 | — | — | — | — | — | 8 | 15 | — | — | — | — | — | — | — | — | 3.5 | <1.0 |
| S52-L | 199.62 | 19.5 | 8.5 | 91 | 6.7 | 14 | 22 | — | 1.3 | 7.3 | 4.0 | 0.18 | 0.07 | 0.18 | 0.05 | 0.04 | 7.0 | <1.0 |
| S53-R | 197.52 | 20.0 | 8.2 | 89 | 6.8 | 14 | 15 | 28 | 1.0 | 7.6 | 2.7 | 0.17 | 0.06 | 0.17 | 0.03 | 0.04 | 7.0 | <1.0 |
| S53-C | 197.52 | — | — | — | — | — | 8 | 18 | — | — | — | 0.11 | <0.01 | 0.14 | 0.04 | <0.01 | 7.0 | 6.0 |
| S53-L | 197.52 | 20.0 | 8.4 | 91 | 6.8 | 15 | 20 | — | 1.0 | 6.1 | 3.7 | 0.24 | 0.08 | 0.17 | 0.04 | 0.04 | 7.0 | <1.0 |
| S54-R | 195.88 | 20.5 | 9.1 | 89 | 6.8 | 17 | 17 | 32 | 1.5 | 9.6 | 5.7 | 0.31 | 0.06 | 0.16 | 0.03 | 0.03 | 6.0 | <1.0 |
| S54-L | 195.88 | 20.8 | 9.1 | 100 | 6.6 | 17 | 17 | — | 1.1 | 9.7 | 4.0 | 0.22 | 0.05 | 0.16 | 0.03 | 0.04 | 6.0 | <1.0 |
| S55-R | 193.85 | 21.3 | 8.2 | 91 | 6.9 | 16 | 18 | — | 1.2 | 17.0 | 4.3 | 0.28 | 0.12 | 0.16 | 0.04 | 0.03 | 16.0 | 5.0 |
| S55-L | 193.85 | 21.7 | 8.0 | 89 | 6.8 | 16 | 17 | — | 1.6 | 29.3 | 4.3 | 0.24 | 0.07 | 0.15 | 0.05 | 0.03 | 6.0 | <1.0 |
| S56-R | 192.81 | 21.5 | 8.1 | 90 | 6.8 | 16 | 17 | — | 1.4 | 11.0 | 4.0 | 0.35 | 0.23 | 0.17 | 0.05 | 0.03 | 7.0 | <1.0 |
| S56-L | 192.81 | 21.7 | 8.0 | 89 | 6.8 | 17 | 21 | — | 1.4 | 10.0 | 4.0 | 0.38 | 0.14 | 0.17 | 0.06 | 0.04 | 6.0 | <1.0 |
| S57 | 188.13 | 21.2 | 8.0 | 88 | 6.9 | 17 | 16 | — | 1.2 | 8.2 | 4.0 | 0.34 | 0.22 | 0.19 | 0.05 | 0.03 | 5.0 | <1.0 |
| S58-L | 187.05 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 11.0 | 7.5 |
| S58-C | 187.05 | 20.7 | 9.1 | 100 | 6.9 | 18 | 10 | 13 | 1.3 | 7.7 | 3.6 | 0.53 | 0.30 | 0.26 | 0.04 | 0.02 | 13.3 | 2.7 |
| S59-R | 186.56 | 21.2 | 8.5 | 94 | 6.8 | 18 | 14 | — | 3.2 | 12.0 | 4.7 | 0.77 | 0.61 | 0.24 | 0.37 | 0.33 | 8.0 | <1.0 |
| S59-L | 186.56 | 21.2 | 9.6 | 106 | 6.8 | 18 | 14 | — | 1.5 | 8.9 | 4.0 | 0.51 | 0.38 | 0.23 | 0.05 | 0.02 | 6.0 | <1.0 |
| S60 | 184.80 | 21.2 | 8.9 | 98 | 6.8 | 19 | 15 | — | 2.2 | 8.9 | 3.3 | 0.69 | 0.50 | 0.22 | 0.23 | 0.17 | 8.0 | <1.0 |
| S61 | 182.78 | 21.5 | 8.1 | 96 | 6.8 | 23 | 14 | 27 | 1.8 | 39.0 | 4.0 | 0.69 | 0.55 | 0.20 | 0.21 | 0.18 | 9.0 | <1.0 |
| S62-R | 181.90 | 21.8 | 8.1 | 9 | 6.8 | 23 | 14 | 32 | 2.5 | 15.0 | 5.7 | 0.72 | 0.51 | 0.23 | 0.24 | 0.20 | 9.0 | <1.0 |
| S62-L | 181.90 | 21.5 | 8.5 | 94 | 6.8 | 20 | 14 | — | 1.7 | 11.0 | 4.0 | 0.73 | 0.50 | 0.23 | 0.18 | 0.18 | 9.0 | <1.0 |
| S63-R | 179.60 | 21.8 | 7.9 | 88 | 6.8 | 21 | 15 | — | 2.1 | 16.0 | 5.0 | 0.57 | 0.39 | 0.21 | 0.19 | 0.17 | 12.0 | 1.0 |
| S63-L | 179.60 | 21.8 | 8.3 | 93 | 6.8 | 21 | 15 | — | 1.9 | 12.0 | 5.0 | 0.59 | 0.37 | 0.23 | 0.19 | 0.17 | 10.0 | <1.0 |
| S64 | 174.45 | 22.3 | 7.8 | 88 | 6.8 | 21 | 16 | — | 1.9 | 14.0 | 4.0 | 0.34 | 0.18 | 0.22 | 0.16 | 0.13 | 10.0 | <1.0 |
| S65 | 157.20 | 22.5 | 7.5 | 85 | 6.8 | 19 | 17 | — | 1.7 | 14.0 | 4.0 | 0.28 | 0.10 | 0.23 | 0.10 | 0.08 | 14.0 | <1.0 |
| S47-A | 129.20 | 24.4 | 7.0 | 82 | 6.8 | 20 | 17 | 30 | 1.4 | 11.0 | 4.0 | 0.20 | 0.10 | 0.36 | 0.10 | 0.07 | 15.0 | 4.0 |
| S47-C | 129.20 | 26.0 | 6.6 | 79 | 6.7 | — | — | 19 | — | — | — | 0.22 | 0.10 | 0.38 | 0.14 | 0.07 | — | — |
| S47-B | 129.20 | 25.0 | 7.0 | 83 | 6.8 | 18 | 16 | — | 1.3 | 38.2 | 3.0 | 0.29 | 0.11 | 0.31 | 0.08 | 0.07 | 9.5 | 3.0 |
| S48-A | 128.08 | 24.5 | 6.1 | 71 | 6.9 | 18 | 17 | 35 | 1.1 | 7.2 | 3.4 | 0.29 | 0.20 | 0.30 | 0.07 | 0.07 | 16.0 | 6.0 |
| S48-B | 128.08 | 24.4 | 7.5 | 80 | 6.8 | 18 | 19 | — | 1.1 | 7.9 | 3.6 | 0.34 | 0.14 | 0.31 | 0.10 | 0.06 | 6.5 | 3.0 |
| S49-A | 118.80 | 25.5 | 7.6 | 90 | 6.8 | 18 | 14 | — | 1.1 | 9.2 | 3.8 | 0.22 | 0.08 | 0.35 | 0.06 | 0.06 | 9.0 | 5.0 |
| S49-B | 118.80 | 25.5 | 7.4 | 88 | 6.9 | 18 | 14 | — | 1.2 | 9.6 | 3.8 | 0.22 | 0.06 | 0.35 | 0.08 | 0.06 | 9.5 | 4.5 |

FIGURE 3

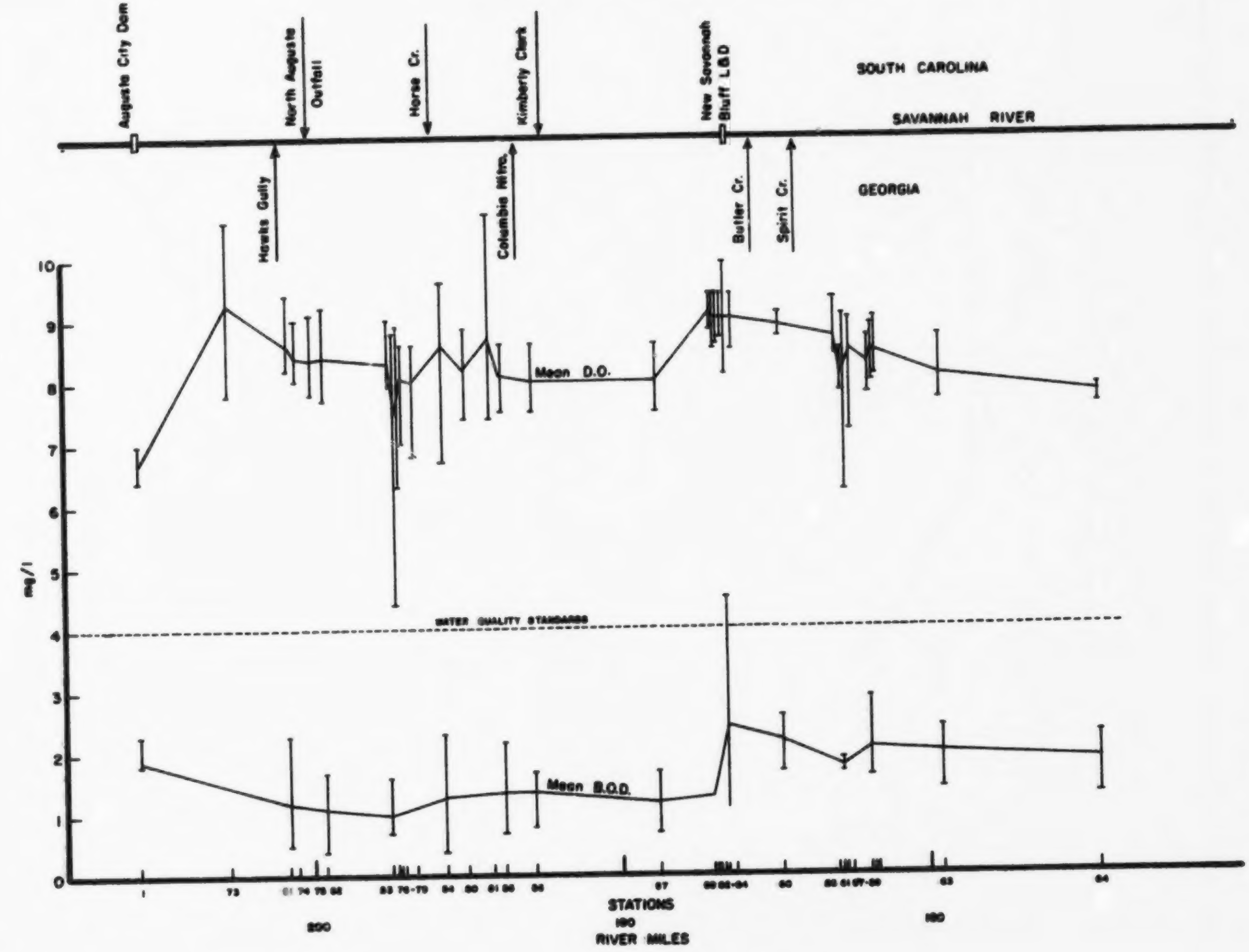

Three Runs Cr.
Three
Mile
Cr.
Upper
Four
Mile
Pen
Br.
Steel Cr.
Lower
Three Runs
Cr.
Savannah River Plant
Atomic Energy Comm.
(S.R.P.)
S.C. 125
Savannah River
GA.
S.C.
1
2
3
4
5
6
7
8
10
11
12
13
KEY
○ Stream Sampling Stations
• S.R.P Production Areas
------ Savannah River Plant Boundary
N
0 1 2 3
Miles

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER PLANT STUDY AREA
OCT, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE 4
DISSOLVED OXYGEN & BIOCHEMICAL OXYGEN DEMAND
SAVANNAH RIVER-AUGUSTA AREA



River over a 24 hour period showed that: (1) The oxygen demanding waste load imposed on this section of the Savannah River was not constant, and (2) the waste load imposed was of sufficient magnitude to obscure the effects of the photosynthetic and respiratory activity of the dense growths of vascular aquatic plants which were present (Appendix C). Total Kjeldahl nitrogen in the Savannah River is noticeably increased from 0.12 mg/l to 0.48 mg/l by discharges from Hawks Gully. Butler Creek and Spirit Creek discharges increased Kjeldahl nitrogen in the Savannah River from 0.4 mg/l to 0.63 mg/l and from 0.54 mg/l to 0.69 mg/l respectively (Figure 5).

Waste from the North Augusta raw sewage outfall, Hawks Gully, and Horse Creek increase the percentage of organic carbon deposits in bottom sediments on the Georgia side of the Savannah River from 0.3 to 3.9 (Table 13). Carbonaceous material in sludge deposits on the South Carolina side of the river increased from 1.66 percent upstream of the North Augusta outfall to 3.02 percent downstream of the outfall. Organic carbon greater than 3.0 percent in sediment indicates artificial deposition by waste sources.[2] Organic carbon content increased from 2.82 percent upstream of Horse Creek to 5.83 percent downstream, indicating substantial waste input to the interstate waters of the Savannah River from Horse Creek.

Bacteriological contamination, however, increased markedly due to untreated and inadequately treated waste discharges introduced to the Savannah River from Georgia and South Carolina sources (Appendix B). A mean fecal coliform bacteria density of 35/100 ml was observed upstream of all sources of wastes. Discharges from Hawks Gully and from the North Augusta sewage outfall increased fecal coliform bacteria densities to 29,000/100 ml and 12,000/100 ml respectively on the Georgia and South

---

[2] Organic Carbon - Organic Nitrogen Ratios in a Polluted Estuary, Finger, J. H. and Wastler, T. A. - Journal of the Water Pollution Control Federation, Research Supplement, February 1969.

# TABLE 13

## SAVANNAH RIVER

## SEDIMENT COD

| Station | Date<br>1970 | COD<br>(mg/kg) | Organic Carbon<br>(%) |
|---|---|---|---|
| | August | | |
| S-73A (L) | 4 | 44,400 | 1.66 |
| S-73 (R) | 4 | 7,900 | 0.30 |
| S-75 (L) | 4 | 80,600 | 3.02 |
| S-75 (R) | 4 | 17,700 | 0.66 |
| S-53 (L) | 4 | 6,160 | 0.23 |
| S-53 (R) | 4 | 75,400 | 2.82 |
| S-76 (L) | 4 | 155,600 | 5.83 |
| S-76 (R) | 4 | 104,100 | 3.90 |
| S-78 (L) | 4 | 69,100 | 2.59 |
| S-78 (R) | 4 | 65,200 | 2.44 |

% = COD divided by 2.67 divided by 10,000.

L and R = left or right side of river looking downstream.

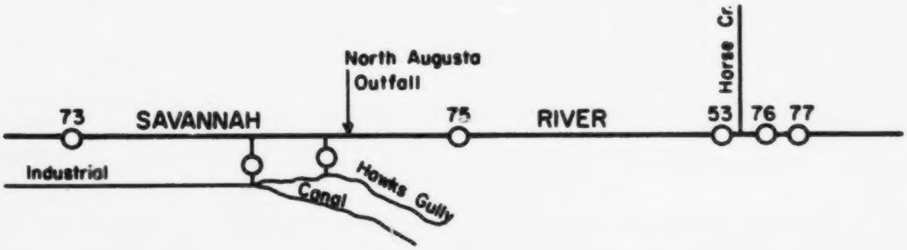
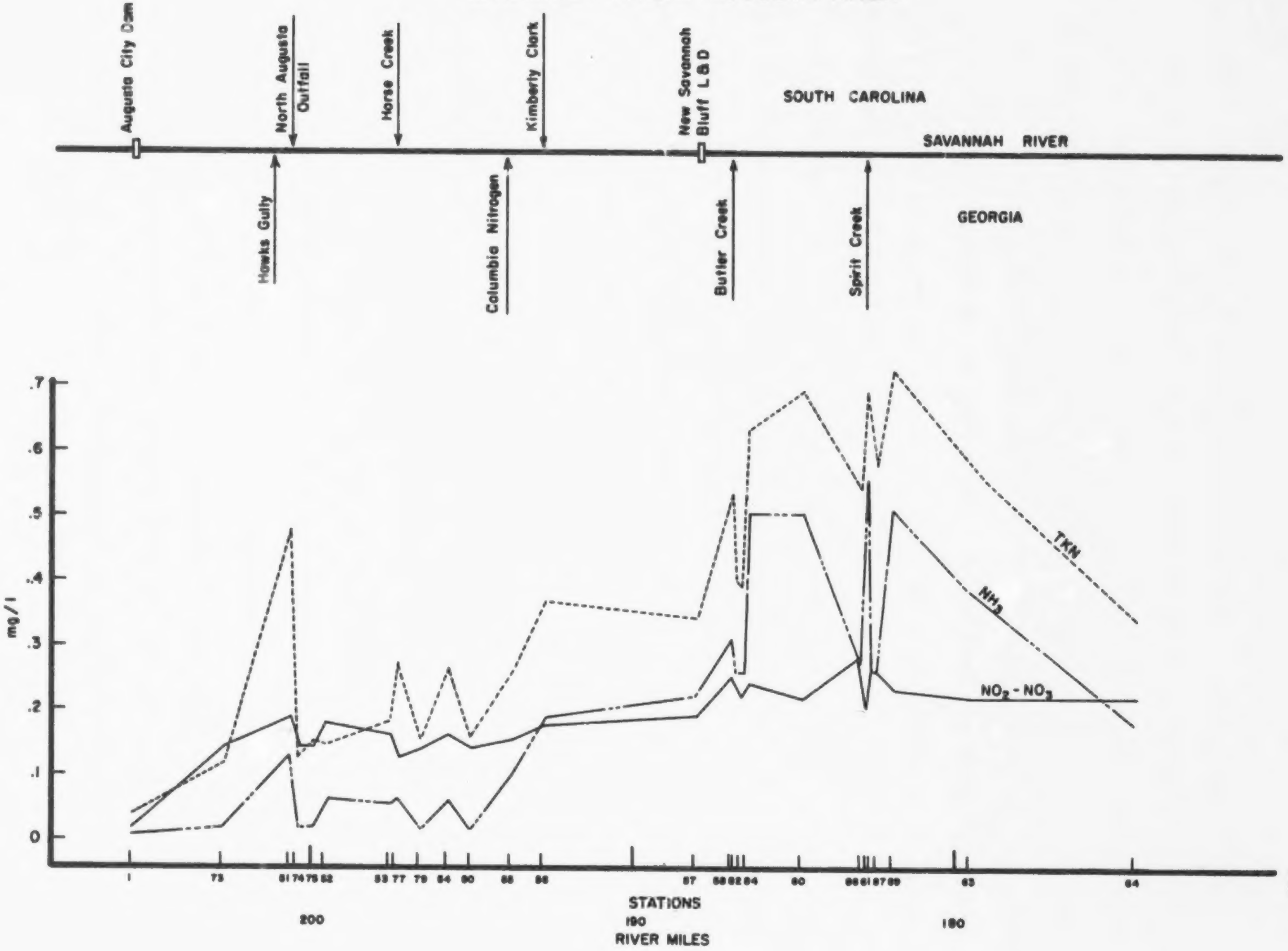

North Augusta
Outfall
73
SAVANNAH
75
RIVER
Horse Cr.
53
76
77
Industrial
Canal
Hawks Gully

FIGURE 5
NITROGEN COMPOUNDS
SAVANNAH RIVER - AUGUSTA AREA



Carolina sides. The Georgia bacterial criterion for fishing and fish propogation (5,000 fecal coliform bacteria per 100 ml) was exceeded from the North Augusta Sewage outfall for the next 18 miles to below the confluence of Spirit Creek. The effect of Horse Creek discharges was not apparent in the Savannah River. However, Butler Creek waste discharges increased fecal coliform bacteria densities on the Georgia side of the river to 160,000/100 ml. Below Spirit Creek, the fecal coliform bacteria density on the Georgia side increased from 44,000/100 ml to 89,000/100 ml. Lower Three Runs Creek discharge did not adversely affect the bacterial quality of the Savannah River. With the exception of the control station, pathogenic Salmonella were isolated at all Savannah River stations in the 74 mile reach sampled. Of the tributaries entering the Savannah River in the study area, discharges from Butler Creek had the greatest detrimental effect on the bacterial quality of the river.

A slimy fibrous sludge deposit covers the bottom of the Savannah River for a distance of 1,000 yards below the confluence of Horse Creek (Appendix C). These sludge deposits, containing 51 to 670 mg/kg of chromium and 3.9 to 5.8 percent organic carbon, are having adverse effects on the biological species in the deposits. Concentrations of chromium in the Savannah River upstream from the Horse Creek confluence are 32 mg/kg. These chromium deposits result from waste discharges from the Gregg Mill of Graniteville Textile Company, Valchem Chemical Company, and the Clearwater Finishing Plant of United Merchants and Manufacturing, Inc.

# APPENDIX A

## SAMPLING LOCATIONS, PROCEDURE AND ANALYTICAL METHODOLOGY

## AUGUSTA AREA - GEORGIA SIDE

### Daily Sample Stations

| | |
|---|---|
| IC-1 | Industrial Canal at drawoff point from Savannah River north of Interstate 20. Collected at base of stone divider extending downstream into the canal from the intake gates. |
| IC-2 | Industrial Canal at Augusta water treatment plant, off of catwalk running along side of 12 inch water main six miles below IC-1. |
| SL-3 | Water supply intake from Industrial Canal for Sibley textile mill downstream side of mill control gate off of gravel road bridge. |
| HG-4 | Hawks Gully outlet from the Industrial Canal at the downstream side of the 15th Street bridge in downtown Augusta. |
| BC-5 | Butler Creek at downstream side of New Savannah Road bridge Ga. Hwy 56 about 2.4 miles above Savannah River confluence. |
| BC-6 | Butler Creek on the downstream side of old truss bridge inside Corps of Engineers New Savannah Bluff Lock and Dam Park and 0.1 mile above the Savannah River confluence. Below confluences of Phinizy Ditch and Cason Dead River. |
| SC-9 | Spirit Creek downstream side of U.S. 1 bridge 16.5 miles above Savannah confluence. |
| SC-10 | Spirit Creek from downstream side of Old Savannah Road bridge Ga. Hwy 56 approximately 3.0 miles above Savannah confluence. |
| SC-11 | Spirit Creek one hundred yards above the Savannah River confluence and above the river's backwaters. |

### Intermittent Sample Stations

| | |
|---|---|
| FG-7 | Fort Gordon sewage treatment plant influent; located behind comminutor. |
| FG-8 | Fort Gordon sewage treatment plant effluent; at overflow weir of secondary clarifier. |
| RC-12 | Reed Creek from Stevens Creek Road culvert. |
| LO-13 | Lake Olmstead drainage to Industrial Canal at downstream side Lake Shore Loop Extension road bridge 0.5 mile from Industrial Canal. |
| G-14 | Gwinnett Street drainage at culvert 1/2 block east of U.S. Hwy 78 on Gwinnett Street. |

| | |
|---|---|
| U-15 | Camille Street ditch downstream side of culvert near Shapiro Packing Company. |
| OC-16 | Oates Creek at downstream side of culvert 1/4 mile south from Shapiro Packing Company. |
| RC-17 | Rocky Creek at downstream side of culvert on New Savannah Road (Loop 56) two miles from U.S. hwy 78 junction. |
| CN-18 | Columbia Nitrogen Caprolactam plant effluent. |
| CN-18' | Columbia Nitrogen Plant effluent. |
| BC-19 | Butler Creek sewage treatment plant at New Savannah Road (Loop 56). |
| CC-20 | Continental Can paper mill effluent taken from their Pond 5 discharge. |
| CC-21 | Continental Can sludge pond effluent. |

Daily sample collection was performed July 6-10, 1970 and intermittent collection July 7, 8, and 9, 1970. All samples were collected once per day except: FG-7, FG-8, CN-18, CN-18', BC-19, CC-20 and CC-21; FG-7, 8, was a special study conducted at Fort Gordon July 6-9. Automatic samplers for set-up for 72 hours of continuous collection with determinations performed every 24 hours; station samples CCN-18, 18', BC-19 were each composites obtained July 8 and 9 by the Georgia Water Control Board; CC-20, 21 were also identified by the Georgia Water Quality Control Board. August 15 and 16, 1970, CC20 was 2-24 hour composites, CC21 was two grabs.

All samples were routinely analyzed for $BOD_5$, DO, fecal coliform bacteria, nitrogen and phosphorus series, TOC, pH, temperature and turbidity. $BOD_2$ alkalinity, COD, and total volatile and suspended solids were only determined July 6 and 7. Color was always analyzed at IC-1, HG-4, CC-20, SC-10 and SC-11. Sulfides and chromium always determined at IC-1 and HG-4. Salmonella detection using the swab technique was performed at IC-2, HG-4, BC-6, FG-8, SC-10 and SC-11.

## SPECIAL STUDIES

### HORSE CREEK VALLEY - SOUTH CAROLINA SIDE

### Procedure

Sampling stations were discriminately positioned on **Horse Creek and tributaries in Horse Creek Valley (i.e. Kelly Creek, Little Horse Creek and Horse Creek).** Control stations above all waste sources were used to define the relative change in water quality. Significant industrial and municipal waste source inputs were sampled concurrently with the tributary stations. All waste source samples were collected as the treated or untreated effluent discharged to the environment. Tributary samples were obtained from the midpoint in steam flow below the surface from bridges or culverts.

Sampling was conducted July 13-17, 1970. Field operations were separated into three coordinated efforts:

1. Daily collection of tributary and waste source points.
2. Intermittent collection of tributary and waste source points.
3. Special studies - composite sampling of three municipal waste sources

### Daily Collection

The following sample stations were collected as grab samples, once per day, July 13-17:

Horse Creek - 25 -- South Carolina highway 33 bridge upstream from Graniteville Company effluent discharge and 10.5 miles above the Savannah River confluence.

Graniteville Mill - 26 -- Waste source to Horse Creek from Gregg Mill operations. Located at wastewater pumphouse prior to discharge and 10.0 miles above Savannah River confluence.

Horse Creek - 27 -- 0.5 mile downstream of Graniteville Company complex at South Carolina Hwy bridge 104.

Kelly Creek - 21 -- Located just above the Aiken City sewage treatment plant discharge on Dibble Road bridge 3.0 miles upstream from the Horse Creek confluence.

Kelly Creek - 22 -- Below the Aitken STP discharge at South Carolina Hwy 421 culvert 1.6 miles above the Horse Creek confluence.

Kelly Creek - 23 -- One hundred yards upstream from the Warrenville sewage treatment plant discharge. A bridge station with sample collection from a small man-made pond just before overflow passes over the weir

Kelly Creek - 24 -- Approximately 0.1 mile below the Warrenville STP discharge to Kelly Creek. The downstream side of South Carolina Hwy bridge 81.

Valchem - 28 -- Chemical division of United Merchants and Manufacturers, Inc. South Carolina Hwy 421, Langley, South Carolina. Waste source discharging from two outfalls 40 yards apart into Horse Creek.

Horse Creek - 29 -- 0.2 mile below Valchem's discharge at South Carolina Hwy 254 bridge. About 6.4 miles above the Savannah River confluence.

Horse Creek - 30 -- 0.8 mile below Bath's waste discharge at 421 bridge.

Little Horse Creek - 31 -- Located 1.4 miles above the Clearwater Finishing Plant wastewater discharge at South Carolina Hwy 67 bridge.

Clearwater Finishing Plant - 32 -- Industrial waste source discharging into Little Horse Creek 0.3 mile upstream of the Horse Creek confluence. All samples were obtained on plant as wastewater flume releases to Little Horse Creek.

Little Horse Creek - 33 -- Below all waste sources discharging into Little Horse Creek at South Carolina Hwy 421 bridge, 0.2 mile upstream from the Horse Creek confluence.

Horse Creek - 34 -- At South Carolina Hwy 145 one mile below the confluence of Little Horse Creek and Horse Creek but above any inputs from an existing Kaolin mine operation.

Horse Creek - 35 -- Below all waste sources into Horse Creek Valley. Located at South Carolina Hwy 125, U.S. Hwy 78 bridge 2.4 miles upstream from the Savannah River.

All tributary and waste source collection points were routinely analyzed for $BOD_5$, dissolved oxygen, fecal coliform bacteria, nitrogen and phosphorus series, TOC, pH, temperature, turbidity, and color. Horse Creek sampling station 35 and the industrial waste source samples (i.e. Graniteville Mill, Clearwater Finishing Plant, Valchem) were also routinely analyzed for Linear Alkayl Sulfonate (biodegradable detergents), pesticides, sulfide and color. Salmonella detection was for 5 days at selected tributary stations (i.e. HC-25, HC-27, HC-30, LHC-31, LHC-33 and HC-35). Total and volatile suspended solids, $BOD_2$, alkalinity and COD were collected only twice during the five day schedule.

Temperature, dissolved oxygen, pH, BOD, fecal coliform bacteria, and turbidity were determined in the field, whereas, the remaining parameters were preserved, if necessary, and transported back to the Southeast Water Laboratory, Athens, Georgia.

## Intermittent

Scheduling required collection only three times July 13-17, except for

Langley Pond, which was sampled twice. The included stations were:

Bath Mill - 38 -- A Horse Creek waste source located at Bath, South Carolina. Only one effluent line discharges to Horse Creek 4.6 miles above the Savannah River confluence.

Seminole Mill - 39 -- Division of United Merchants and Manufacturers, Inc., industrial waste source discharging to Little Horse Creek located adjacent to Clearwater Finishing Plant, Clearwater, South Carolina. One collection point, on plant, as the wastewater is released from their 6-inch outfall line to Little Horse Creek approximately 0.3 mile above the Horse Creek confluence.

Kimberly Clark - 40 -- Beech Island, South Carolina, was sampled below their lagoon discharge at the U.S.G.S. gaging station on the Dead River.

Langley Pond - 42 -- A man-made impoundment of Horse Creek. Collection was approximately 100 yards above the Valchem discharges to Horse Creek just before the impounded water passed through the flood control gates.

All waste sources were routinely analyzed for 5-day BOD, dissolved oxygen, fecal coliform, nitrogen and phosphorus series, TOC, pH, temperature, and turbidity. Pesticides, LAS, 2-day BOD, sulfides, chromium, alkalinity, and COD were intermittently determined once. Langley Pond 42 followed the same schedule except pesticides, sulfides, LAS, and chromium were ommitted from intermittent determinations.

## Special Studies

Composite sampling was performed at Warrenville Sewage Treatment Plant (STP), Aiken STP, and North Augusta outfall (W-36, A-37 and NA-41). Serco automatic samplers were used every hour. Bacteriological analyses were obtained by grab sampling. *Salmonella* detection continued for five days by hanging a cloth swab in the wastewater at the collection point. Determinations made in the field were: pH, $BOD_5$, $BOD_2$, turbidity and fecal coliform bacteria. The remainder (sulfides, chromium, TOC, COD, alkalinity, total volatile suspended solids, total suspended solids, phosphorus and nitrogen series, and LAS) were preserved, if necessary, and transported back to the Southeast Water Laboratory, Athens, Georgia.

## LOWER THREE RUNS

### Procedure

Samples were obtained by car and boat on July 20-22, 1970. All stations were sampled twice per day, time permitting. Samples were shuttled back to the mobile lab in Augusta for analysis and/or preparation for shipment to the Southeast Water Laboratory, Athens. The tributary station samples were collected one foot below the surface using a Kemmerer sampler. Savannah River stations were collected two feet from the bottom on the first run and one foot from the surface on the last. J. P. Stevens was the only waste source sampled.

All samples were routinely analyzed for $BOD_5$, DO, nitrogen and phosphorus series, TOC, pH, temperature and turbidity. Intermittent determinations on samples collected the first run July 20 and 21 were: $BOD_2$, alkalinity, COD, and total and volatile solids. Bacteriological analyses were fecal coliform bacteria and Salmonella detection. Fecal coliform bacteria samples were obtained on the first run each day at stations LTR-43, JPS-44, LTR-45, and LTR-46. Cloth swabs for Salmonella detection were fixed for five days at stations LTR-43, JPS-44, LTR-46, S-47-A and S-47-B. These same stations were intermittently (first run, July 20 and 21) analyzed for color, pesticides, sulfides, and Linear Alkyl Sulfonate (biodegradable detergents).

### Vehicle Stations

Lower Three Runs - 43 -- South Carolina Hwy 66 bridge upstream of Stevens Mill effluent and 6.7 miles above the Savannah River confluence.

J. P. Stevens - 44 -- Waste source 0.5 mile north of South Carolina Hwy 125 on Hwy 3, Allendale County. Sampled at concrete collection box behind plant.

Lower Three Runs - 45 -- Hwy 125 bridge below Stevens effluent and 4.0 miles above Savannah River confluence.

Boat Stations

Lower Three Runs - 46 -- Approximately 50 yards upstream from Savannah River confluence.

Savannah River - 47A & B-- Approximately 0.1 mile upstream of Lower Three Runs confluence (R.M. 129.2). "A" is the left third point looking downstream, "B" is the right third point.

Savannah River - 48A & B -- One mile below Lower Three Runs confluence at Little Randall Point (R.M. 128.2) - "A" and "B" as above.

Savannah River - 49A & B -- North bound U.S. 301 bridge (R. M. 118.8) - "A" and "B" as above.

The following is a complete listing of all the stations used in the chemical, biological and bacteriological phases of the study.

STATION DESCRIPTIONS (River mile in parenthesis)

S72 - 100 yards above the South Carolina Utilities Dam (207.62)

S50 - At the Augusta City Dam (207.60)

S73 - At North Augusta water intake (202.72)

S51 - 100 yards north of 13th Street Bridge (200.73)

S74 - 200 yards south of 13th Street Bridge (200.52)

S75 - Opposite 8th Street (200.00)

S52 - At 5th Street boat ramp (199.62)

S53 - 200 yards above the mouth of Horse Creek (197.52)

S76 - 100 yards below the mouth of Horse Creek (197.34)

S77 - 300 yards below the mouth of Horse Creek (197.26)

S78 - 500 yards below the mouth of Horse Creek (197.14)

S79 - 1,000 yards below the mouth of Horse Creek (196.70)

S54 - 200 yards upstream of highway 28 bridge (195.88)

S80 - Slightly downstream of channel marker #96 (195.10)

S81 - 300 yards below the Columbia Nitrogen outfall ditch adjacent to the Columbia Nitrogen water intake (194.22)

S55 - 850 yards below the Columbia Nitrogen waste ditch (193.85)

S56 - 200 yards downstream of the Kimberley Clark-Dead River waste discharge (192.81)

S57 - 100 yards upstream of the New Savannah Bluff Lock and Dam (188.13)

S58 - 100 yards upstream of the mouth of Butler Creek, but below the New Savannah Bluff Lock and Dam (187.05)

S82 - 100 yards below the mouth of Butler Creek (186.88)

S83 - Adjacent to boat ramp 300 yards below the mouth of Butler Creek (186.80)

S84 - 500 yards below the mouth of Butler Creek (186.70)

S59 - At new Savannah Bluff Landing offshore of farthest downstream boat ramp (186.56)

S85 - 1,200 yards below the mouth of Butler Creek at channel marker #95 (186.30)

S60 - Upstream of Twiggs Lower Bar and Continental Can water intake channel (184.80)

S86 - 300 yards above the mouth of Spirit Creek, slightly below channel marker #87 (183.00)

S61 - 100 yards above the mouth of Spirit Creek (182.78)

S87 - 100 yards below mouth of Spirit Creek (182.72)

S88 - 300 yards below the mouth of Spirit Creek (182.62)

S89 - 500 yards below the mouth of Spirit Creek (182.52)

S62 - Slightly above Bailey's Cut but below the mouth of Spirit Creek (181.90)

S90 - Adjacent to channel marker #86 at the mouth of Bailey's Cut (181.82)

S91 - 100 yards below the mouth of Bailey's Cut (181.70)

S63 - At Hill's Landing by channel marker #84 (179.60)

S64 - At the Silver Bluff Landing opposite the ramp (174.45)

S65 - At the Savannah River Plant automatic monitor intake (157.20)

S47 - 150 yards above the mouth of Lower Three Runs Creek (129.20)

S66 - 100 yards below the mouth of Lower Three Runs Creek (129.00)

S67 - 300 yards below the mouth of Lower Three Runs Creek (128.82)

S68 - 500 yards below the mouth of Lower Three Runs Creek (128.64)

S69 - 700 yards below the mouth of Lower Three Runs Creek (128.52)

S70 - 1,000 yards below the mouth of Lower Three Runs Creek (128.36)

S71 - 1,500 yards below the mouth of Lower Three Runs Creek (128.14)

S48 - One mile below the mouth of Lower Three Runs Creek (128.09)

S49 - At U.S. 301 bridge (118.80)

## ANALYTICAL METHODOLOGY

The following methods were used by Environmental Protection Agency personnel:

| Analyses | Method | Reference |
|---|---|---|
| pH<br>Temperature<br>DO | Laboratory Instrument Meter Fischer Scientific Dail Thermometer Modified Winkler with Full-Bottle Technique | FWPCA Methods Manual Nov. 1969 |
| BOD | As prescribe (Dilutian water a 50-50 solution of distilled and Savannah River water obtained at New Savannah Bluff Lock and Dam) | FWPCA Methods Manual Nov. 1969 |
| Kjeldahl Nitrogen | Technicon-digestion & Phenolate | FWPCA Methods Manual Nov. 1969 |
| $NH_3$ - Nitrogen | Technicon-Sodium Phenolate | FWPCA Methods Manual Nov. 1969 |
| Nitrate-Nitrite, Nitrogen | Technicon-Cadmium Reduction | FWPCA Methods Manual Nov. 1969 |
| Total Phosphorus | Technicon - Manual digestion & automated single reagent | FWPCA Methods Manual Nov. 1969 |
| Orthophosphate | Technicon - Single Reagent | FWPCA Methods Manual Nov. 1969 |
| Organic Carbon (TOC) | Beckman Carbonaceous Analyzer | FWPCA Methods Manual Nov. 1969 |
| Chemical Oxygen Demand (COD) | Dichromate Reflux - 0.25N | Standard Methods, 12th Edition |
| Chemical Oxygen Demand (COD) | Dichromate Reflux - 0.25N | FWPCA Methods Manual |
| Sulfide | Iodometric | Standard Methods,12t |
| Turbidity | Hach 2100 Turbidimeter | FWPCA Methods Manual |
| Chromium, Total | Atomic Absorption | FWPCA Methods Manual |
| Color | Platinum, Cobalt Visual | FWPCA Methods Manual |
| Suspended Solids, Total (Non-Filterable) | Glass-Fiber Filteration, 105°C | FWPCA Methods Manual |

| Analyses | Method | Reference |
|---|---|---|
| Volatile Suspended Solids | Gravimetric, 550°C | Standard Methods,12th Edition |
| Sediment Samples - All Analyses Based on Dry Weight | | |
| Chemical Oxygen Demand | Dichromate Reflux 0.25N | Standard Methods,12th Edition |
| Organic Nitrogen | Manual Digestion and Distillation Technicon - Sodium Phenolate | FWPCA Methods Manual Nov. 1969 |
| Total Phosphorus | Technicon - Manual Digestion & Automated Single Reagent | FWPCA Methods Manual Nov. 1969 |
| Chromium, Hcl & $HNO_3$ Extractable | Hcl, $HNO_3$ digestion & Atomic Absorption | FWPCA Methods Manual Nov. 1969 |
| Pesticides | Gas Chromotography using electron capture detector (extraction solvent 15 percent methylene chloride in hexane). | FWPCA Method for Chlorinated Hydrocarbon Pesticides on Water and Waste-Water April 1969 |

## SAVANNAH RIVER PLANT

### Sampling Station Description

| | |
|---|---|
| UTR-1 | Upper Three Runs Creek control station at SRP Road F bridge |
| UTR-2 | Upper Three Runs Creek at South Carolina Highway 125 bridge |
| UTR-3 | Upper Three Runs Creek 75 yards upstream from Savannah River |
| FMC-4 | Four Mile Creek Control Station at culvert 4000 feet down dirt road from SRP Road E |
| FMC-5 | Four Mile Creek at South Carolina Highway 125 bridge |
| FMC-6 | Four Mile Creek 50 yards upstream from Savannah River |
| PB-7 | Pen Branch control station at culvert 3000 feet down dirt road from SRP Road C |
| PB-8 | Pen Branch at South Carolina Highway 125 bridge |
| ST-10 | Steel Creek at South Carolina Highway 125 bridge |
| ST-11 | Steel Creek 50 yards upstream from Savannah River |
| LTR-12 | Lower Three Runs Creek Control Station at culvert 2000 feet down dirt road from SRP Road 8 |
| LTR-13 | Lower Three Runs Creek at South Carolina Highway 66 bridge |

# APPENDIX B

## BACTERIAL WATER QUALITY MIDDLE REACH OF THE SAVANNAH RIVER

## TABLE OF CONTENTS

Page No.

INTRODUCTION . . . . . . . . . . . . . . . . . . . . . . . . . . . B-1

SUMMARY. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . B-2

CONCLUSIONS. . . . . . . . . . . . . . . . . . . . . . . . . . . . B-4

STUDY AREA . . . . . . . . . . . . . . . . . . . . . . . . . . . . B-4

STUDY FINDINGS . . . . . . . . . . . . . . . . . . . . . . . . . . B-6

I. FECAL COLIFORM BACTERIA RESULTS. . . . . . . . . . . . . . . . . B-6

- A. GEORGIA SOURCES. . . . . . . . . . . . . . . . . . . . . . . . B-6
  - 1. Industrial Canal . . . . . . . . . . . . . . . . . . . . . B-6
  - 2. Butler Creek . . . . . . . . . . . . . . . . . . . . . . . B-7
  - 3. Spirit Creek . . . . . . . . . . . . . . . . . . . . . . . B-7
- B. SOUTH CAROLINA SOURCES . . . . . . . . . . . . . . . . . . . . B-7
  - 1. Horse Creek Drainage . . . . . . . . . . . . . . . . . . . B-7
    - a. Kelly Creek. . . . . . . . . . . . . . . . . . . . . . B-7
    - b. Little Horse Creek. . . . . . . . . . . . . . . . . . . B-8
    - c. Horse Creek. . . . . . . . . . . . . . . . . . . . . . B-8
  - 2. Lower Three Runs Creek . . . . . . . . . . . . . . . . . . B-9
- C. SAVANNAH RIVER - IN THE AUGUSTA AREA . . . . . . . . . . . . . B-9
- D. SAVANNAH RIVER - IN THE LOWER THREE RUNS CREEK AREA. . . . . . B-12

II. SALMONELLA IN WATERS STUDIED. . . . . . . . . . . . . . . . B-13

SAMPLING PROCEDURES AND METHODOLOGY. . . . . . . . . . . . . . . . B-16

REFERENCES . . . . . . . . . . . . . . . . . . . . . . . . . . . . B-9

# LIST OF TABLES

| Number | Title | Follows Page No. |
|---|---|---|
| B-I | Sample Station Locations and Descriptions | B-20 |
| B-II | Daily Fecal Coliform Bacteria Densities at all Stations Sampled | B-20 |
| B-III | Summary of Fecal Coliform Bacteria Data For the Entire Study | B-20 |
| B-IV | The Ten Most Frequently Reported Salmonella Serotypes During July 1970 | B-20 |
| B-V | List of Sampling Sites for Salmonella and the Serotypes Recovered | B-20 |
| B-VI | Comparisons of Mean Fecal Coliform Bacteria Levels at Selected Sites that also had Salmonella Present | B-20 |
| B-VII | Identification Scheme for Salmonella Suspects | B-20 |

## LIST OF FIGURES

| No. | Title | Follows Page No. |
|---|---|---|
| B-1 | Fecal Coliform Densities in the Augusta, Georgia Area | B-7 |
| B-2 | Fecal Coliform Densities in the Horse Creek, South Carolina, Drainage Area | B-8 |
| B-3 | Fecal Coliform Densities in the Lower Three Runs Creeks, South Carolina, Drainage Area | B-9 |
| B-4 | Fecal Coliform Densities in the Savannah River in the Augusta Area | B-11 |
| B-5 | Fecal Coliform Densities in the Savannah River in the Lower Three Runs Creek Area | B-12 |
| B-6 | Average Daily Fecal Coliform Discharges to the Savannah River from the Major Waste Sources | B-12 |

# APPENDIX B

## Bacterial Water Quality

By

B. J. Carroll and R. E. Gentry

## INTRODUCTION

A comprehensive water quality survey of the middle reach of the Savannah River was conducted by the Technical Services Program, Southeast Water Laboratory, Environmental Protection Agency during the summer of 1970. The survey included the examination of water quality of the Savannah River and its major tributaries in Georgia and South Carolina. The bacterial water quality portion of this survey included the analysis for fecal coliform bacteria and qualitative examinations for *Salmonella.*

Waters receiving domestic, wildlife and/or livestock wastes are characterized by the presence of bacteria which normally inhabit the intestinal tracts of warm-blooded animals, including man. The coliform group is the most numerous group of bacteria found in human excreta. Several genera with similar biochemical properties comprise this group. Some genera occur naturally outside the intestinal tract, a fact that has caused objections to the use of this group as indicators of fecal pollution.

Many objections to using coliform bacteria as indicators of fecal pollution were overcome with the work of Clark, *et al.*, (1), Geldreich, *et al.*, (2), (3), and Geldreich (4). Advances resulting from these studies enhanced the differentiation of the coliform bacteria group into sub-groups of fecal and non-fecal origin. The fecal coliform bacteria group is presently the most reliable bacterial measure of fecal pollution. All bacteriological samples collected during this study were analyzed for fecal coliform bacteria.

Though generally considered non-pathogenic, coliforms are considered to indicate the probable presence of enteric pathogens. Some enteric pathogens and coliform bacteria found in polluted water, if ingested, may cause gastronenteritis, dysentery, typhoid fever, and/or paratyphoid fever. Although not necessarily related to enteric pathogens, ear, eye, nose, throat, and skin infections and/or irritations are commonly contracted from contact with polluted waters. Viral diseases, such as infectious hepatitis and polio, may also result from contact and ingestion of water receiving fecal wastes.

Perhaps the easiest of the enteric pathogens to isolate are members of the genus Salmonella. Salmonella is a large serologically related genus comprised of some 1300 serotypes. All Salmonella are considered pathogenic for man, animals, or both. They are discharged from an infected host by excretal discharges. The presence of Salmonella in environmental waters is proof not only of fecal contamination but also conclusively establishes the potential for disease contraction resulting from water ingestion.

## Summary

During the study period, July 6 to August 4, 1970 fecal coliform bacteria determinations were made on 312 samples collected at 82 stations. Qualitative examinations and identification of serotypes was made for members of the genus Salmonella at 29 selected stations. The mean fecal coliform bacteria densities observed at the sampling stations ranged from < 20 to 73,000,000/100 ml. Salmonella were recovered at 85 percent of the stations sampled, with a total of 27 different serotypes identified.

Mean fecal coliform bacteria contributions to the Savannah River from Georgia and South Carolina tributaries are:

Georgia

- o Industrial Canal - 20,000/100 ml
- o Butler Creek - 5,900,000/100 ml
- o Spirit Creek - 800/100 ml

South Carolina

- o Kelly Creek - 170,000/100 ml
- o Little Horse Creek - 14,000/100 ml
- o Horse Creek - 74,000/100 ml
- o Lower Three Runs Creek - 230/100 ml.

Each of these tributaries receives fecal contamination from point sources or tributaries within their respective drainage basins.

Samples collected at both Augusta and North Augusta raw water intakes contained Salmonella. With the exception of the control station, Salmonella were detected at all Savannah River stations. The stations sampled span approximately 74 miles of stream.

## Conclusions

1. The bacterial quality of the Savannah River is significantly degraded as it flows through the greater Augusta area. The adverse effect on bacterial quality results from the cumulative domestic and industrial wastes discharged directly to the Savannah River from Georgia and South Carolina and those transported via tributaries. As a result of waste discharges within the greater Augusta area, the bacterial criteria established for the Savannah River by the State of Georgia are violated for a minimum of 18 river miles.

2. Of the tributaries entering the Savannah River within the study area, Butler Creek (Georgia) appears to have the greatest detrimental effect on the bacterial quality of the river.

3. There must be some measure of standardization of bacterial standards for similar water-use classifications as they apply to stateline streams. If variance in permissable bacterial levels is allowed for each side of the same stream reach, only inequitable enforcement of standards can result. Such a standardization must be accomplished between the states of Georgia and South Carolina on the Savannah River.

## Study Area

The study area includes the Augusta Standard Metropolitan Statistical Area (SMSA) (Richmond County, Georgia, and Aiken County, South Carolina), the AEC Savannah River Plant and adjacent industries located in Barnwell and Allendale Counties, South Carolina. The Augusta SMSA encompasses 1,410 square miles with a population of 393,000.

The interstate waters in the study area are classified by the respective states as to their water-use. With most classifications, fecal coliform bacteria levels are established to control the microbiological suitability of these waters. Both Georgia and South Carolina have established water-use classifications which contain permissable bacterial levels for the portion of the Savannah River in the study area. Both states have classified the river from Clarke Hill Dam to the 13th Street bridge in Augusta as a domestic raw water source. Under this classification, Georgia requires a monthly mean fecal coliform bacteria density not to exceed 5000/100 ml with not more than 5 percent of the samples during a 90-day period exceeding 20,000/100 ml (5). South Carolina requires an arithmetic monthly mean fecal coliform bacteria density of 2000/100 ml for the same reach of stream (6).

From the 13th Street bridge downstream to U. S. Highway 301 (approximately mile 129), Georgia classified this reach for fishing and fish propagation. Under this classification, Georgia requires a monthly mean fecal coliform bacteria level not to exceed 5000/100 ml, with not more than 5 percent of the samples during any 90-day period exceeding 20,000/100 ml. Downstream from U. S. Highway 301 to U. S. Highway 17 (approximately mile 22), Georgia has a classification of drinking water. This classification requires a monthly fecal coliform bacteria mean not to exceed 50/100 ml with not more than 5 percent of the samples exceeding 200/100 ml during any 90-day period.

From the 13th Street bridge to Upper Three Runs Creek (approximately mile 157), South Carolina has this reach of stream classified for fish propagation, industrial and agricultural usage. Under this classification, no bacterial criterion is recommended. From Upper Three Runs Creek to U. S. Highway 17 (approximately mile 22), South Carolina has the stream classified for domestic water supply. Under this classification, a monthly arithmetic mean fecal coliform bacteria level not to exceed 2000/100 ml is required for standard compliance.

# STUDY FINDINGS

During the study period, from July 6 to August 4, 1970 fecal coliform bacteria (FC) analyses were made on 312 samples collected at 82 stations. Qualitative examinations were made for members of the genus Salmonella at 29 selected stations. Station locations and descriptions are contained in Table B-I. Results of FC analyses are contained in Table B-II and summarized in Table B-III. Figures B-1 through B-5 show the station locations and the mean FC densities at these stations.

## I. Fecal Coliform Bacteria Results

### A. Georgia Sources

### 1. Industrial Canal

A major portion of the canal flow enters the Savannah River through Hawk's Gully with a mean[1/] FC density of 20,000/100 ml as measured at station HG-4 (0.5 mile from confluence). Combined city sewers, located between stations SI-3 and HG-4, contribute most of the bacterial pollution to the canal. The control station, IC-1, was located above all defined waste sources, and had a mean FC density of 35/100 ml (Table B-III).

Some of the canal flow is diverted from Hawk's Gully to the Beaver Dam ditch system which drains into Butler Creek.

### 2. Butler Creek

Butler Creek discharged a mean FC density of 5,900,000/100 ml to the Savannah River as measured at station BC-6 (0.1 mile from confluence). Most bacterial pollution enters Butler Creek from Cason Dead River.

---

[1/] All mean values are geometric.

Cason Dead River receives drainage containing domestic, industrial, and storm water runoff from Oates Creek, Camille Street Ditch, Beaver Dam Ditch, and some of the industrial canal flow.

The Butler Creek STP, located 0.8 mile from confluence, discharged a mean FC density of 1,300/100 ml to Butler Creek.

The control station, BC-5 (located 2.5 miles from confluence) and a mean FC density of 480/100 ml indicating some fecal pollution above this point.

### 3. Spirit Creek

Spirit Creek contributed a mean FC density of 800/100 ml to the Savannah River as measured at station SC-11 (100 feet above confluence). The Ft. Gordon sewage treatment plant located approximately 17 miles above the confluence is the major contributor of fecal waste to Spirit Creek. The plant effluent, station FG-8, had a mean FC density of 1,500,000/100 ml. Natural purification processes greatly reduce the FC density in Spirit Creek by the time its flow enters the Savannah River.

## B. South Carolina Sources

### 1. Horse Creek Drainage

#### a. Kelly Creek

Kelly Creek contributed a mean FC density of 170,000/100 ml to Horse Creek as measured at station KC-24 (0.4 mile above confluence). The major sources of bacterial pollution are the Aiken and Warrenville sewage treatment plant effluents. The Aiken STP effluent, station A-36, (2.8 miles above confluence) discharged a mean FC density of 7,400,000/100 ml. The Warrenville STP effluent, station W-37, (0.5 mile above confluence) discharged a mean FC density of 2,800,000/100 mi. The control station, KC-21. (3.0 miles above confluence) had a mean FC density of 190/100 ml.

### b. Little Horse Creek

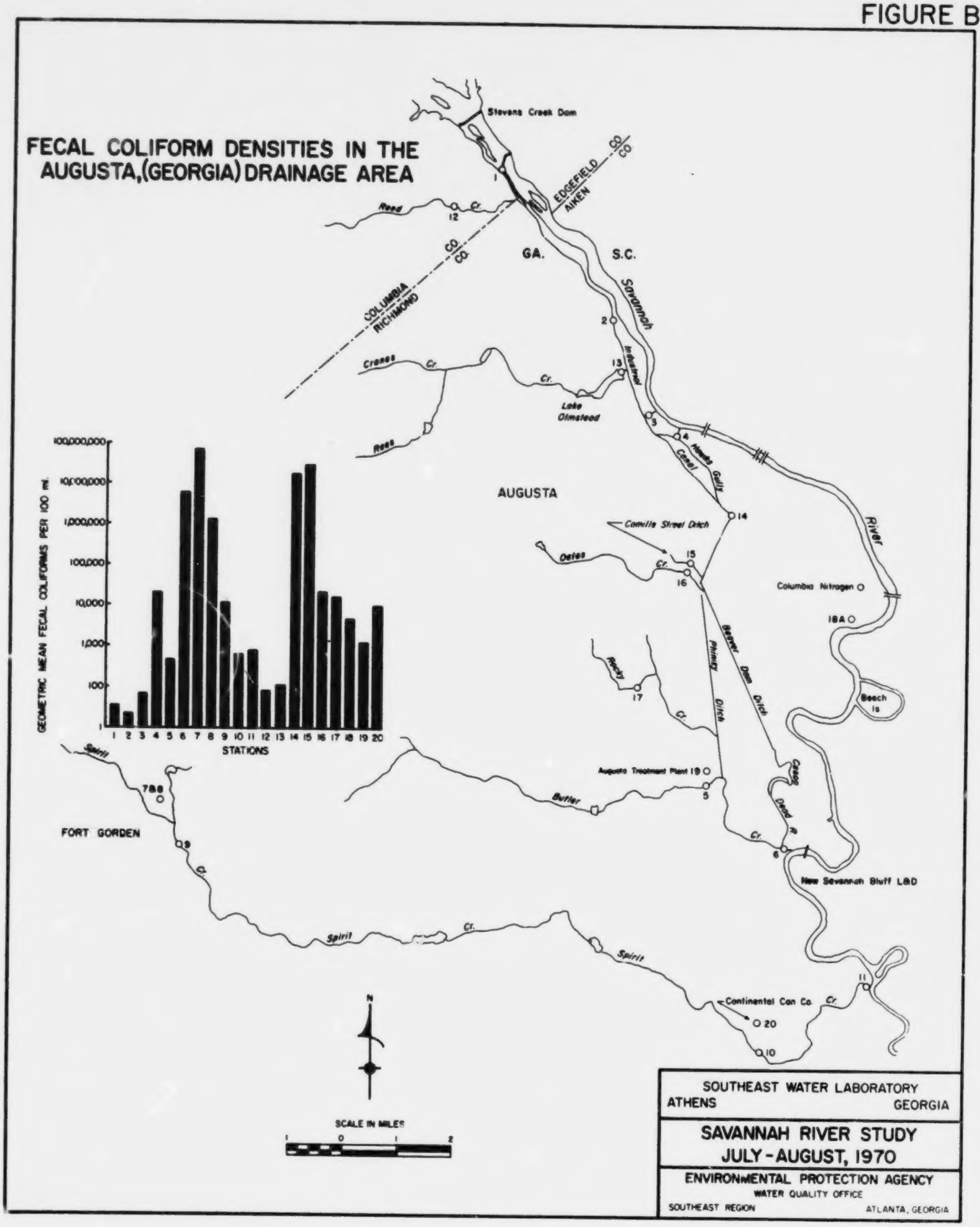
Little Horse Creek contributed a mean FC density of 14,000/100 ml to Horse Creek as measured at station LHC-33 (0.1 mile above confluence). The only defined waste sources on Little Horse Creek are the Clearwater Finishing Plant and the Seminole Mills. The Clearwater Finishing Plant (0.3 mile above confluence) discharged an effluent with a FC density of <20/100 ml. The Seminole Mill has two effluents discharging into Little Horse Creek, of which only one was accessible for sampling. This effluent, station SM-39, had a mean FC density of 340/100 ml. The inaccessible effluent discharges raw domestic waste which was the major source of the high FC density at station LHC-33. The control station LHC-31 (1.7 miles above confluence) had a mean FC density of 630/100 ml, indicating some fecal pollution from an undefined source.

### c. Horse Creek

Horse Creek contributed a mean FC density of 74,000/100 ml to the Savannah River as measured at station HC-35 (1.6 miles above confluence). The major sources of bacterial pollution enter Horse Creek via Kelly Creek and Little Horse Creek. Several mills contribute some bacterial pollution to Horse Creek. The Bath Mill, station B-38, (4.6 miles above confluence), discharged waste with a mean FC density of 970/100 ml. The Valchem plant, station V-28, (6.6 miles above confluence) discharged waste with a mean FC density of 780/100 ml. The Graniteville Textile Mill, station GM-26, (10.0 miles above confluence) discharged waste with a FC density of <20/100 ml. The reduced FC densities in Horse Creek below this station suggest a toxic waste was being discharged. The control station, HC-25, (10.5 miles above confluence) had a mean FC density of 220/100 ml.

FIGURE B-1

FECAL COLIFORM DENSITIES IN THE AUGUSTA,(GEORGIA) DRAINAGE AREA


Stevens Creek Dam
1
Reed
12
Cr.
EDGEFIELD CO
AIKEN CO
COLUMBIA CO
RICHMOND CO
GA.
S.C.
Savannah
2
Industrial
13
Cranes
Cr.
Cr.
Lake Olmstead
Rees
3
4
Canal
Hawks Gully
AUGUSTA
14
Camille Street Ditch
Dales
Cr.
15
16
Columbia Nitrogen
18A
River
Rocky
17
Cr.
Phinizy
Ditch
Beaver Dam Ditch
Beech Is
Augusta Treatment Plant 19
5
Butler
Cr.
Dead R.
Cr.
6
New Savannah Bluff L&D
Spirit
7&8
FORT GORDEN
9
Cr.
Spirit
Cr.
Spirit
Cr.
11
Continental Can Co.
20
10
N
SCALE IN MILES
1
0
1
2
GEOMETRIC MEAN FECAL COLIFORMS PER 100 ml.
100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
100
1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
STATIONS

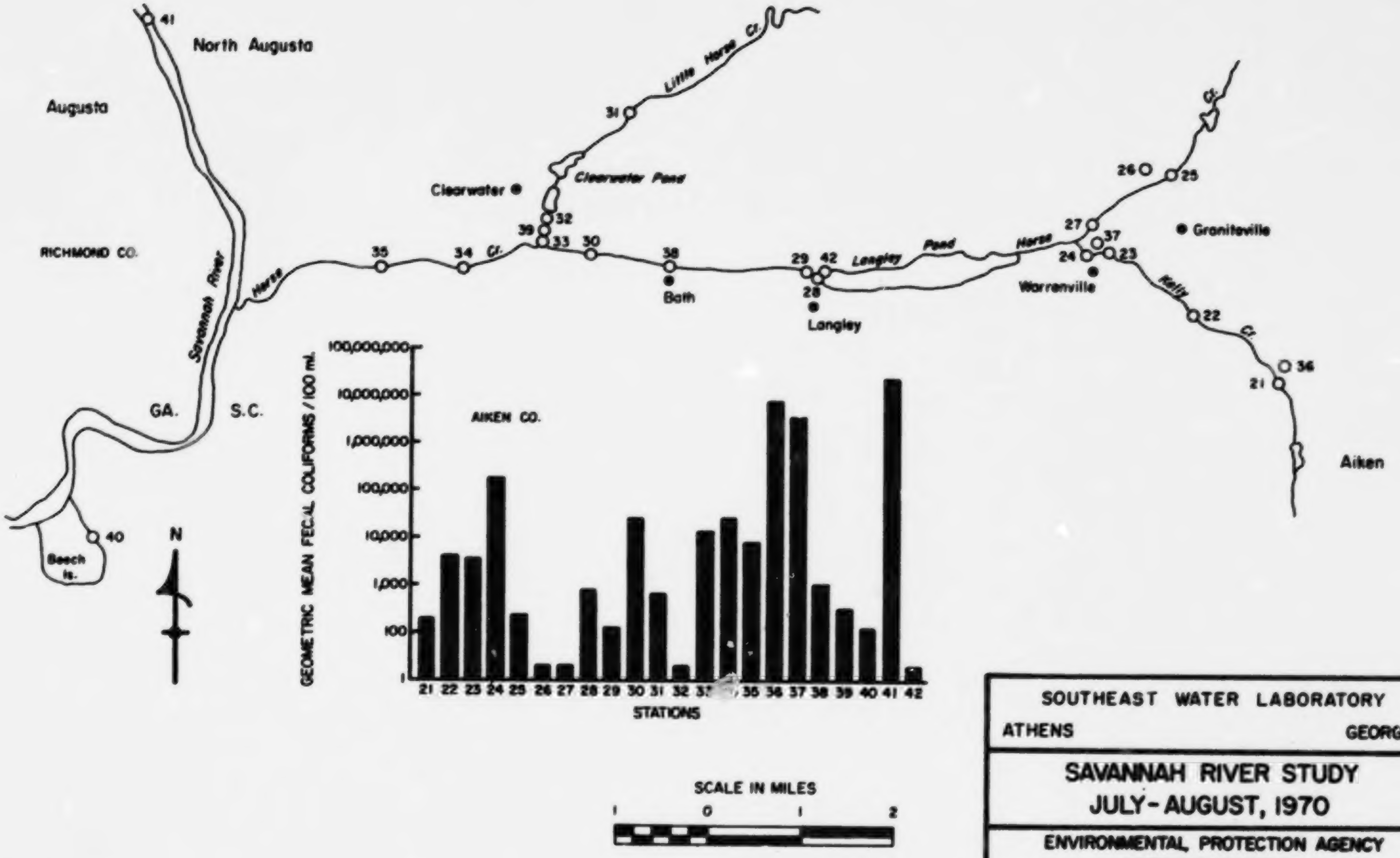
SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY-AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE B-2

# FECAL COLIFORM DENSITIES IN THE HORSE CREEK, (SOUTH CAROLINA) DRAINAGE AREA


41
North Augusta
Augusta
RICHMOND CO.
Savannah River
Horse
GA.
S.C.
40
Beech Is.
N
35
34
Cr.
39
32
33
30
Clearwater
Clearwater Pond
31
Little Horse Cr.
38
Bath
29
42
28
Langley
Langley Pond
Horse
27
24
37
23
Warrenville
Graniteville
26
25
Cr.
Kelly
22
Cr.
21
36
Aiken
AIKEN CO.
GEOMETRIC MEAN FECAL COLIFORMS / 100 ml.
100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
100
1
21 22 23 24 25 26 27 28 29 30 31 32 33 35 36 37 38 39 40 41 42
STATIONS
SCALE IN MILES
1 0 1 2

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY-AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

### 2. Lower Three Runs Creek

Lower Three Runs Creek contributed a mean FC density of 230/100 ml to the Savannah River as measured at station LTR-46 (100 feet above confluence). The only defined bacterial pollution source entering Lower Three Runs Creek is the J. P. Stevens Plant. This effluent, station JPS-44, had a mean FC density of 6,900,000/100 ml. The effect of this high FC density waste was not reflected in the FC density at station LTR-46. The control station LTR-43 (6.7 miles above confluence) had a mean FC density of 66/100 ml.

## C. Savannah River - Augusta City Dam (mile 207.5) to below Spirit Creek (mile 182.6)

Figure 4 shows the mean FC densities at the stations in this reach of the stream. Figure 6 shows the average daily FC discharges entering this reach during the study period.

Station S-50, located immediately upstream of the Augusta Dam, serves as a control station for the Savannah River within the study area. The bacterial quality of the stream at this point was good, as was reflected by a mean FC density of 35/100 ml. Compliance with both the Georgia and South Carolina bacterial standards is easily attained at this point. This good quality water extends downstream some five miles, where at station S-73 the mean FC density was 44/100 ml.

The first major source of bacterial pollution entering the Savannah River is the industrial canal (mile 201.2) which discharged 503 mgd with a mean FC density of 20,000/100 ml. Some 0.5 mile downstream, North Augusta, South Carolina, discharges raw sewage (.95 mgd) with a mean FC density of 21,000,000/100 ml (NA-41) into the Savannah River.

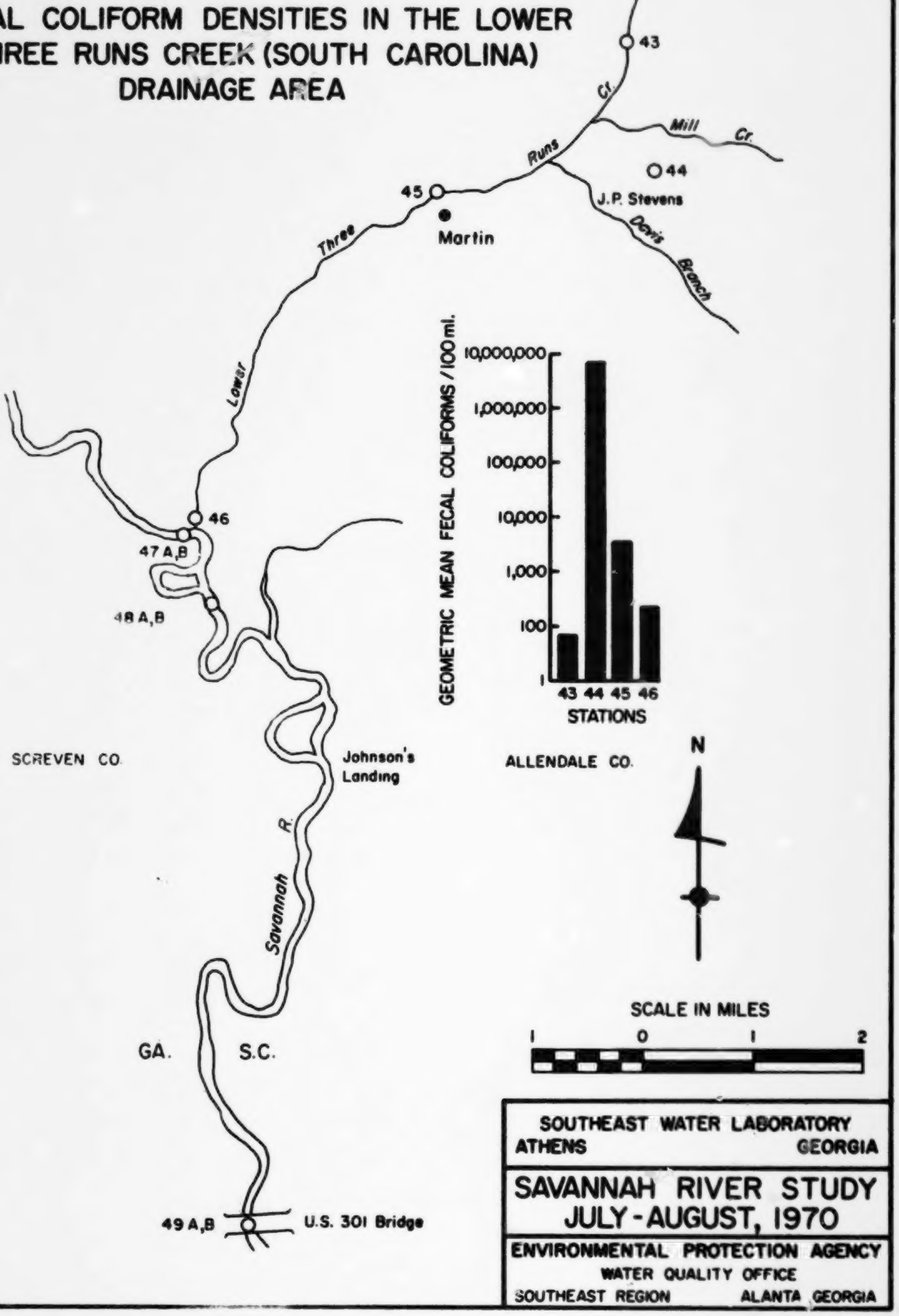
The cumulative effect of these waste sources on the bacterial quality of the Savannah River was observed at stations 74A and 74E which are located approximately 0.1 mile downstream from the North Augusta outfall. At these stations, the mean FC densities were 29,000/100 ml and 12,000/100 ml for the Georgia and South Carolina sides, respectively.

As a result of these discharges, the bacterial criteria established for these waters by the State of Georgia are violated. The established State standards continue to be violated for approximately the next 18 miles on the Georgia side of the Savannah River. The inability to comply with the standards in this reach of stream is further complicated by additional waste input downstream.

Approximately three miles downstream of S-74, the mean FC density on the Georgia side remained at 29,000/100 ml, as a result of the waste discharge from the City of Augusta's Second Street outfall. On the South Carolina side there was a reduction in mean FC density to 7,500/100 ml as measured at station S-53. This station is located approximately 0.1 mile above the confluence of Horse Creek with the Savannah River.

FIGURE B-3

FECAL COLIFORM DENSITIES IN THE LOWER THREE RUNS CREEK (SOUTH CAROLINA) DRAINAGE AREA



43
Cr.
Mill Cr.
Runs
O 44
45
J.P. Stevens
Martin
Three
Davis Branch
Lower
GEOMETRIC MEAN FECAL COLIFORMS / 100 ml.
10,000,000
1,000,000
100,000
10,000
1,000
100
1
43 44 45 46
STATIONS
46
47 A,B
48 A,B
SCREVEN CO.
Johnson's Landing
ALLENDALE CO.
N
Savannah R.
SCALE IN MILES
1 0 1 2
GA.
S.C.
49 A,B
U.S. 301 Bridge

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JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
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Horse Creek, the first major tributary entering the Savannah River from South Carolina within the study area, discharged 103 mgd with a mean FC density of 7,400/100 ml. Although this stream receives significant bacterial pollution upstream, the magnitude of this waste is not reflected in the mean FC density discharged into the Savannah River. The bacterial quality of the river is not appreciably effected by this discharge. Station S-77, located approximately 0.3 mile below Horse Creek, was characterized by a mean FC density on the South Carolina side of 8,000/100 ml.

The next defined waste source, Butler Creek, enters on the Georgia side at mile 187. Butler Creek discharged 54 mgd with a mean FC density of 5,900,000/100 ml. Immediately upstream of the confluence of Butler Creek at station S-58, the mean FC levels of 11,000 and 16,000/100 ml on the Georgia and South Carolina sides, respectively, indicated a generally well-mixed situation. The impact of the Butler Creek discharge was evidenced at station S-83, approximately 0.3 mile below Butler Creek. The mean FC densities measured were 160,000/100 ml, 62,000/100 ml, and 20,000/100 ml for the Georgia side, midstream, and South Carolina side, respectively. Of the tributaries entering the Savannah River within the study area, Butler Creek had the greatest detrimental effect on the bacterial quality of the river.

Spirit Creek enters the Savannah approximately 4.2 miles downstream of the Butler Creek confluence. At station S-86, approximately 0.2 mile above Spirit Creek, the mean FC densities were 44,000/100 ml and 93,000/100 ml on the Georgia and South Carolina sides, respectively. The reduced FC density on the Georgia side possibly resulted from the toxic effect of chlorine discharged to the river by the Olin Corporation.

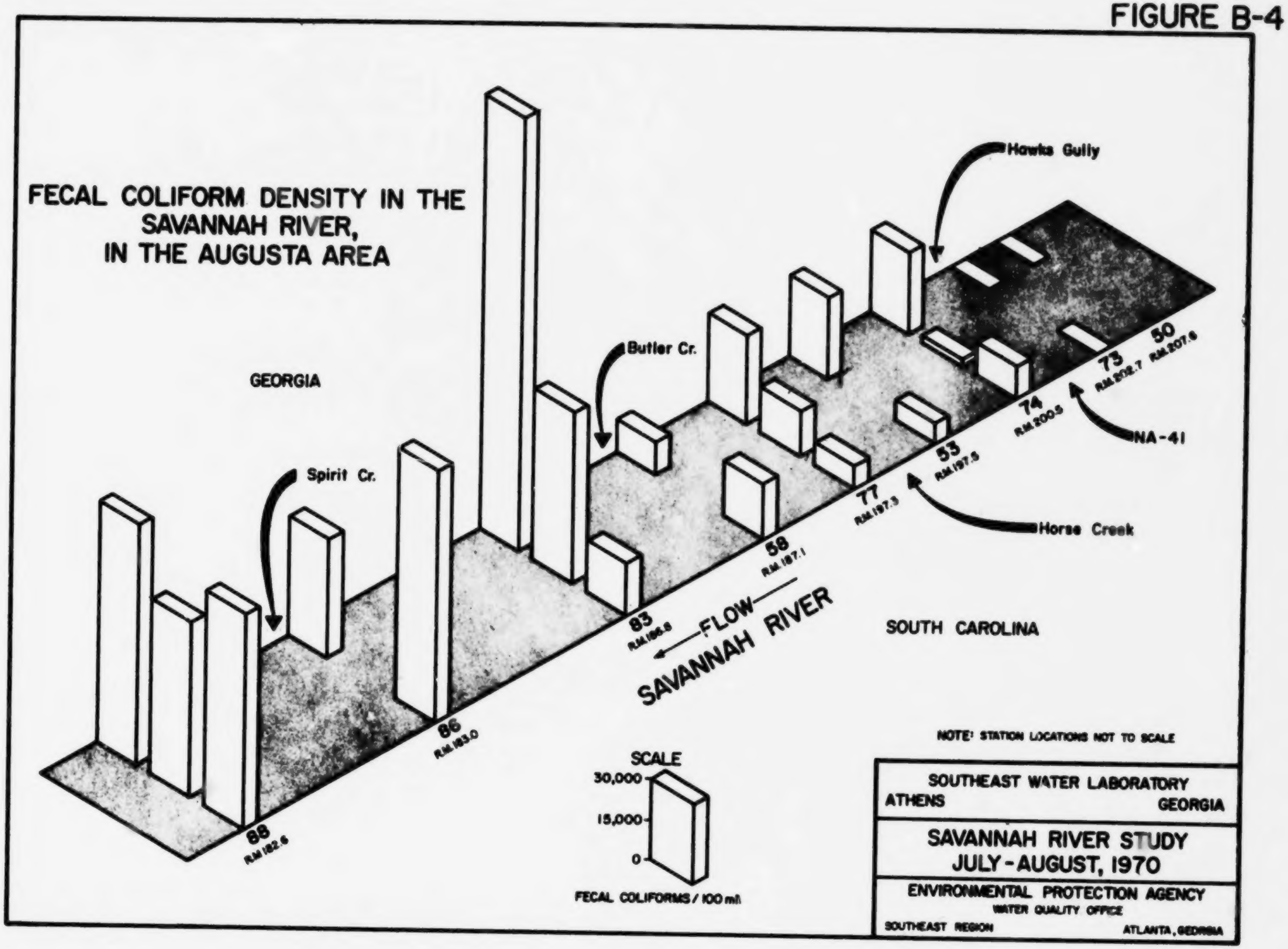
Spirit Creek discharged 65 mgd with a mean FC density of 800/100 ml. Station S-88, located 0.2 mile downstream of the confluence, had mean FC densities of 89,000/100 ml, 64,000/100 ml, and 79,000/100 ml on the Georgia side, midstream, and South Carolina side, respectively. A comparison of the densities above and below the Spirit Creek confluence suggested that Spirit Creek caused an increased indicator level in the river. Based on the low level of indicators being discharged together with the levels across the river below the confluence, it appears that mixing which occurs between stations S-86 and S-88 may account for this increase, rather than the discharge itself.

The next station located on the Savannah River is approximately 53 miles downstream.

### D. Savannah River - In the Lower Three Runs Creek Area

Station S-47, located approximately 500 yards above the confluence of Lower Three Runs Creek, had mean FC densities of 2,000/100 ml and 1,900/100 ml on the Georgia and South Carolina sides, respectively. These densities indicated a partial recovery of the river from the bacterial pollution of the greater Augusta area and was also indicative of a well-mixed condition. Lower Three Runs Creek enters the Savannah with a mean FC density of 230/100 ml, as measured at station LTR-46. Generally, Lower Three Runs Creek does not adversely affect the bacterial quality of the river as shown by the FC densities measured at station S-66. The mean FC densities measured were 1,100 and 1,200/100 ml for the Georgia and South Carolina sides, respectively. However, within the immediate area of the confluence of Lower Three Runs Creek, drainage from surrounding swamp lands possibly results in the elevation of bacterial indicator levels measured at stations S-67, S-68, S-69, S-70, and S-71, Figure 5.

FIGURE B-4



FECAL COLIFORM DENSITY IN THE SAVANNAH RIVER, IN THE AUGUSTA AREA

NOTE: STATION LOCATIONS NOT TO SCALE

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JULY - AUGUST, 1970

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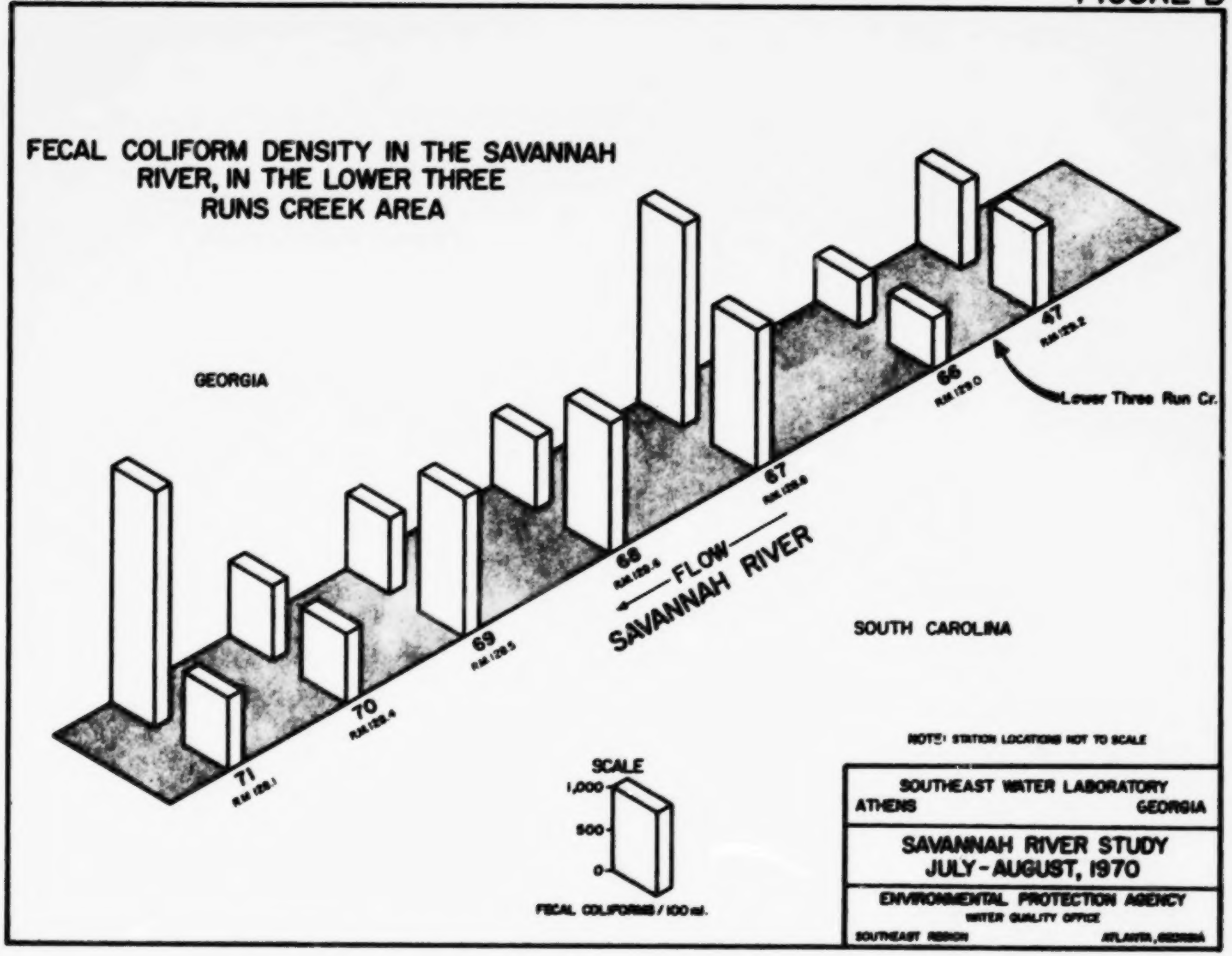
FIGURE B-5



FECAL COLIFORM DENSITY IN THE SAVANNAH RIVER, IN THE LOWER THREE RUNS CREEK AREA

NOTE: STATION LOCATIONS NOT TO SCALE

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JULY - AUGUST, 1970

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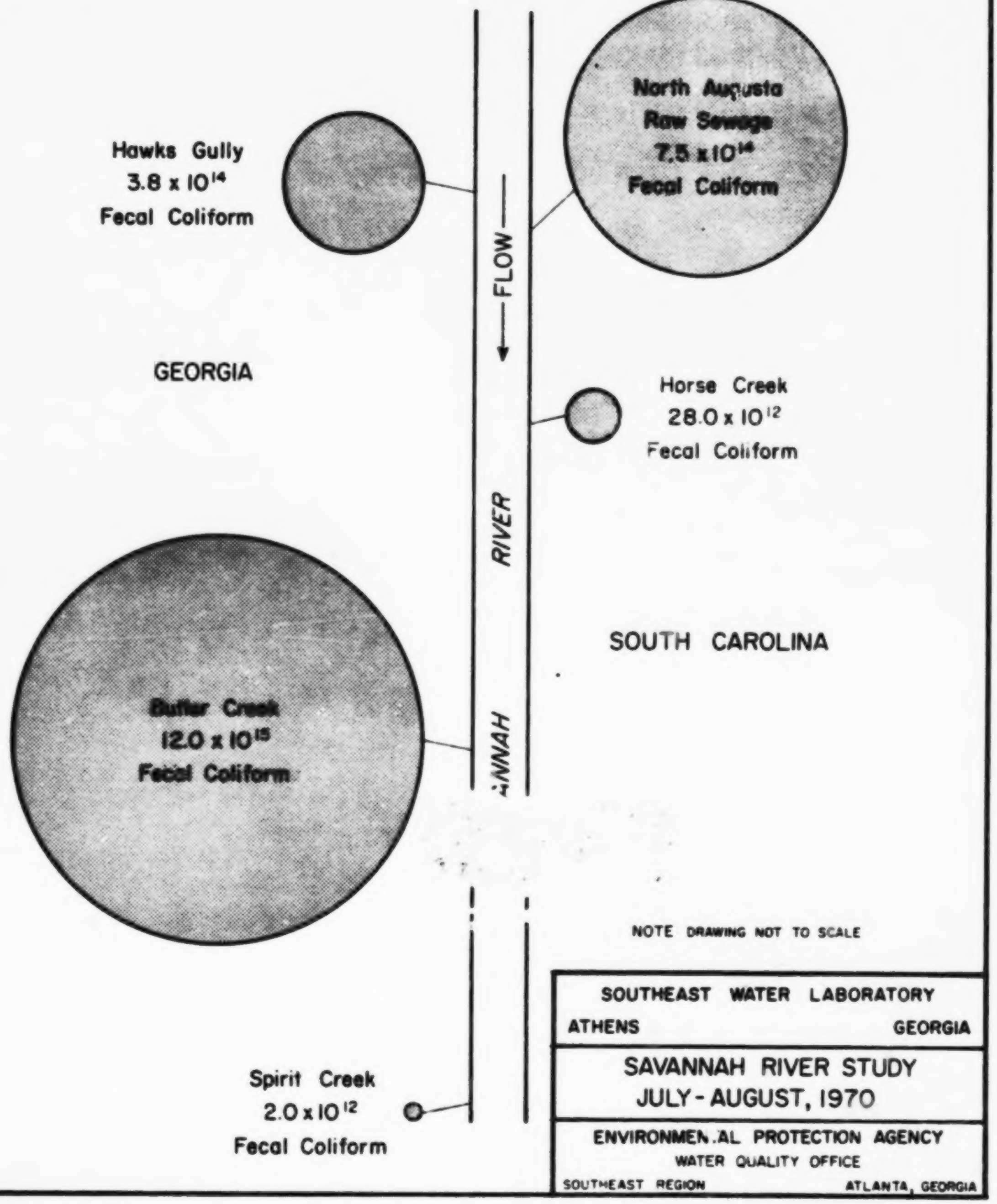
FIGURE B-6

AVERAGE DAILY FECAL COLIFORM DISCHARGES TO THE SAVANNAH RIVER FROM THE MAJOR WASTE SOURCES


Hawks Gully
3.8 x 10^14
Fecal Coliform
North Augusta
Raw Sewage
7.5 x 10^14
Fecal Coliform
FLOW
GEORGIA
Horse Creek
28.0 x 10^12
Fecal Coliform
RIVER
SOUTH CAROLINA
Butler Creek
12.0 x 10^15
Fecal Coliform
ANNAH
Spirit Creek
2.0 x 10^12
Fecal Coliform

NOTE DRAWING NOT TO SCALE

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JULY - AUGUST, 1970

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## II. Salmonella in Waters Studied

In addition to the determination of fecal coliform bacteria densities within the study area, special efforts were made to detect members of the genus Salmonella at selected sites. The relative density of an indicator is generally viewed to indicate the relative magnitude of wastes being discharged. Moreover, as the indicator level increases, so does the probability of enteric pathogen presence increase. The one undeniable fact is that if the pathogen is isolated at a sampling site, the disease producing capacity of this water is established.

The ten most frequently isolated Salmonella from both human and non-human sources for July, 1970, are shown in Table B-IV(12). Of the top ten isolates from human sources, seven were isolated during this study. These were S. typhimurium (including variety copenhagen), S. newport, S. heidelberg, S. saint paul, S. thompson, S. derby, and S. montevideo. Of the top ten isolates from non-human sources, five were among the isolates of this study. These were S. typhimurium (including variety copenhagen), S. heidleberg, S. anatum, S. saint paul, and S. montevideo.

A total of 27 different Salmonella serotypes were isolated during the study; these are listed according to station locations in Table B-V. Of the sites where Salmonella detection was attempted, 85 percent were found to be positive for these organisms; see Table B-V.

A comparison of fecal coliform levels with the presence of Salmonella is shown in Table B-VI. As illustrated by these data, Salmonella were isolated on occasions when mean FC densities were 24 and 43/100 ml, and not isolated when the mean FC densities were 14,000 and 6,900,000/100 ml. The inability to isolate Salmonella at the higher FC levels does not infer the insignificance of the FC group as indicators of fecal contamination. Rather, the inability to isolate Salmonella at the higher FC densities possibly results from analytical inadequacies (swab technique), sporatic discharge of these pathogens, availability of host animals, or a combination of these factors. The failure to isolate Salmonella at relatively high FC densities have been observed by numerous workers (13) (14) (15).

The isolation of Salmonella at low FC densities, <100/100 ml was observed during this study. Similar observations have been made by other investigators (14) (16). Although the low FC densities are not reflective of significant fecal contamination, the isolation of Salmonella at these low levels establish the disease-producing capacity of these waters. The source of these organisms, although not defined, could be due to an endemic animal population of an area.

The recovery of Salmonella at sites where the FC densities were very low simply underscores the fact that low indicator values alone does not negate the possibility of pathogen presence.

Salmonella were isolated from each tributary stream entering the Savannah River, with the exception of Lower Three Runs Creek. All Savannah River stations, except for the control station (S-50), were positive for Salmonella.

Both the Augusta and North Augusta raw water intakes were positive for Salmonella. At the Augusta intake, S. muenchen, S. mississippi, and S. give were isolated, while at the North Augusta intake, S. newport and S. panama were detected. Both water intakes are located above any defined wastes discharges which would suggest a possible animal source for these pathogens. The presence of these organisms at the water intakes emphasizes the necessity of maintaining adequate water treatment practices together with continuous bacterial monitoring of the finished waters to avoid transmission of these organisms in the public water supply.

The isolation and identification of Salmonella at each of the Savannah River stations between station S-73A and station S-70A indicated approximately 74 miles of this stream could be potentially hazardous for water contact activities. The fact that Salmonella were recovered at 85 percent of the stations sampled and that 27 different serotypes were identified establishes the magnitude and, to a degree, the variety of sources of the fecal pollution in the area.

## SAMPLING PROCEDURES AND METHODOLOGY

### Sampling

All samples analyzed for indicator bacteria were collected at or near the surface using selected grab techniques. The samples were collected in sterile glass containers and placed on ice until time of analysis. Most samples were analyzed within six hours of collection.

In the case of some stream stations, left and right bank and mid-stream samples were collected. Left and right banks were designated by facing downstream. The sampling regime was dictated by both the physical characteristics of the stream and available waste source information. Most of the stations were sampled on several different days, although not necessarily on consecutive days. Samples were collected to reflect variable stream flows and diel bacterial variations. Some composite samples were collected.

Samples collected for the purpose of isolating Salmonella were obtained using a modification of the swab technique of Moore (7). Sanitary napkins (swabs) were folded, gauze ends tied together, and a length of heavy string was attached. The swabs were then wrapped in heavy kraft paper and sterilized. The sterile swabs were suspended just beneath the water surface at selected sampling stations. After 3-5 days, the swabs were retrieved, placed in sterile plastic bags, and returned to the laboratory for analysis.

## Bacteriological Examination

Fecal coliform bacteria enumeration: The fecal coliform procedure outlined in Standard Methods (8) for the MPN multiple tube dilution was used. The procedure employs the standard presumptive test using Lauryl Tryptose Broth followed by fecal coliform confirmation using E. C. Medium at an elevated temperature (44.5° ± 0.5°C, waterbath).

Salmonella isolation and identification: Swabs used for isolation purposes were placed into wide-mouth jars containing approximately 200 ml of 1-1/2 strength Tetrathionate Broth with brilliant green added (1:100,000 w/v). The inoculated enrichment was incubated from 18 to 24 hours at 41.5°C according to the procedure of Spino (9). Some of the primary Brilliant Green Tetrathionate (BGT) enrichments were subcultured to SBG Sulfa Enrichment medium and incubated an additional 18-24 hours at 35°C. After either primary of subculture enrichment and inoculum from each enrichment was streaked onto Bismuth Sulfite Agar (BS), XLBG Agar, Taylor (XLBG) and Hektoen Enteric Agar (HE) plates and incubated at 35°C for 18-36 hours. Suspected Salmonella colonies were picked from the respective plates and subjected to the identification scheme outlined in Table B-VII.

The methods and media outlined in Table B-VII are described by Ewing (10), with the exception of the cytochrome oxidase and lysine decarboxylase methods. Oxidase and decaroxylase activity was determined using Patho-Tec-CO[1/] and Patho-Tec-LD[1/] reagent impregnated paper strips, respectively.

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[1/] Does not imply endorsement of these products.

Definitive serological identification of Salmonella isolates was made at the Southeast Water Laboratory. The methodology used was the standard serological procedures described by Edwards and Ewing (11). Verification of these identifications was made by the Enteric Bacteriology Unit of the National Center for Disease Control, Atlanta.

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## TABLE B-I

## SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Description |
|---|---|
| IC-1 | Industrial Canal at draw-off point from Savannah River north of Agusta. |
| IC-2 | Industrial Canal at Augusta water intake. |
| S1-3 | Water supply intake from Industrial Canal for Sibley textile mill. |
| HG-4 | Hawks Gully outlet from Industrial Canal to the Savannah River at Broad Street bridge just north of 15th Street. |
| BC-5 | Butler Creek from New Savannah Road bridge. |
| BC-6 | Butler Creek from bridge in Corps of Engineer park upstream of confluence with Savannah River. |
| FG-7 | Influent to Ft. Gordon sewage treatment plant. |
| FG-8 | Effluent from Ft. Gordon sewage treatment plant. |
| SC-9 | Spirit Creek from U. S. 1 bridge. |
| SC-10 | Spirit Creek from Old Savannah Road bridge (Ga. 56). |
| SC-11 | Spirit Creek upstream of confluence with Savannah River. |

## TABLE B-I cont'd

## SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Descriptions |
|---|---|
| **Intermittent Samples Collected:** | |
| RC-12 | Reed Creek from Stevens Creek Road culvert. |
| LO-13 | Lake Olmstead drainage to Industrial Canal at Lake Shore Loop extension. |
| G-14 | Gwinnet Street drainage ditch to Beaver Dam Ditch. |
| U-15 | Unnamed ditch near Shapiro Packing Company from New Savannah Road culvert. |
| OC-16 | Oates Creek at New Savannah Road culvert. |
| RO-17 | Rocky Creek at New Savannah Road bridge. |
| CN-18 | Columbia Nitrogen caprolactum plant effluent. |
| CN-18a | Columbia Nitrogen (Nitrogen plant effluent). |
| BC-19 | Butler Creek sewage treatment plant effluent. |
| CC-20 | Continental Can paper mill effluent. |
| KC-21 | Kelly Creek at Dibble Road bridge upstream of Aiken sewage treatment plant effluent. |

## TABLE B-I cont'd

## SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Descriptions |
|---|---|
| KC-22 | Kelly Creek at Highway 421 culvert downstream of Aiken effluent. |
| KC-23 | Kelly Creek at road leading to Warrenville sewage treatment plant upstream of effluent. |
| KC-24 | Kelly Creek at Highway 81 bridge downstream of Warrenville effluent. |
| HC-25 | Horse Creek on Highway 33 bridge upstream of Graniteville textile mill. |
| HC-27 | Horse Creek at Highway 104 bridge downstream of Graniteville effluent. |
| HC-29 | Horse Creek at Highway 254 bridge near Langley and upstream of inflowing branch. |
| HC-30 | Horse Creek at Highway 421 bridge downstream of Bath. |
| HC-34 | Horse Creek at Highway 145 bridge upstream of kaolin mining activity. |
| HC-35 | Horse Creek at Highway 125-278 bridge. |
| LP-42 | Overflow from Langley Pond on Horse Creek upstream of Valchem effluent. |

## TABLE B-I cont'd

## SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Descriptions |
|---|---|
| LHC-31 | Little Horse Creek on Highway 67 bridge upstream of Clearwater Finishing Plant effluent. |
| LHC-33 | Little Horse Creek at Highway 421 bridge downstream of effluents. |
| GM-26 | Effluent from Graniteville textile mill. |
| V-28 | Effluent from the Valchem plant. |
| CM-32 | Clearwater Finishing Plant effluent. |
| A-36 | Aiken sewage treatment plant. |
| W-37 | Warrenville sewage treatment plant effluent. |
| B-38 | Bath Mill effluent. |
| SM-39 | Seminole Mill effluent. |
| KC-40 | Kimberly-Clark effluent. |

## TABLE B-I cont'd

## SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Description |
|---|---|
| NA-41 | North Augusta sewer outfall at 13th Street. |
| LTR-43 | Lower Three Runs Creek in the vicinity of Highway 66 bridge. |
| LTR-45 | Lower Three Runs Creek at Highway 125 bridge. |
| LTR-46 | Lower Three Runs Creek 100 feet above confluence with the Savannah River. |
| JPS-44 | J. P. Stevens textile mill effluent. |
| S-50-A[1] | Savannah River at Augusta City Dam near entrance to Industrial Canal north of Augusta, left bank. |
| S-73A | Savannah River at North Augusta water intake, left bank. |
| S-73E[2] | Savannah River at North Augusta water intake, right bank. |
| S-74A | Savannah River approximately 200 yards south of 13th Street bridge in Augusta, left bank. |

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[1] A - left bank (South Carolina side) facing downstream

[2] E right bank (Georgia side) facing downstream

## TABLE B-I cont'd

## SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Description |
|---|---|
| S-74C[3/] | Savannah River approximately 200 yards south of 13th Street bridge in Augusta, mid-stream. |
| S-74E | Savannah River approximately 200 yards south of 13th Street bridge in Augusta, right bank. |
| S-53-A | Savannah River approximately 200 yards upstream of Horse Creek, left bank. |
| S-53E | Savannah River approximately 200 yards upstream of Horse Creek, right bank. |
| S-77A | Savannah River approximately 300 yards below mouth of Horse Creek, left bank. |
| S-77C | Savannah River approximately 300 yards below mouth of Horse Creek, right bank. |
| S-77E | Savannah River approximately 300 yards below mouth of Horse Creek, right bank. |
| S-58A | Savannah River approximately 100 yards upstream of Butler Creek and below New Savannah Bluff lock and dam, left bank. |
| S-58E | Savannah River approximately 100 yards upstream of Butler Creek and below New Savannah Bluff lock and dam, right bank. |

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[3/] C - Midstream

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Description |
|---|---|
| S-83A | Savannah River at boat ramp approximately 300 yards below mouth of Butler Creek, left bank. |
| S-83C | Savannah River at boat ramp approximately 300 yards below mouth of Butler Creek, mid-stream. |
| S-83E | Savannah River at boat ramp approximately 300 yards below mouth of Butler Creek, right bank. |
| S-86A | Savannah River just downstream of channel marker # 87 and approximately 300 yards above mouth of Spirit Creek, left bank. |
| S-86E | Savannah River just downstream of channel marker # 87 and approximately 300 yards above mouth of Spirit Creek, right bank. |
| S-88A | Savannah River Approximately 300 yards below mouth of Spirit Creek, left bank. |
| S-88C | Savannah River approximately 300 yards below mouth of Spirit Creek, midstream. |
| S-88E | Savannah River approximately 300 yards below mouth of Spirit Creek, right bank. |

## TABLE B-I cont'd

## SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Description |
|---|---|
| S-47A | Savannah River at channel marker # 48 approximately 500 yards above the mouth of Lower Three Runs Creek, left bank. |
| S-47E | Savannah River at channel marker # 48 approximately 500 yards above the mouth of Lower Three Runs Creek, right bank. |
| S-66A | Savannah River approximately 100 yards below mouth of lower Three Runs Creek, left bank. |
| S-66E | Savannah River approximately 100 yards below mouth of Lower Three Runs Creek, right bank. |
| S-67A | Savannah River approximately 300 yards below mouth of Lower Three Runs Creek, left bank. |
| S-67E | Savannah River approximately 300 yards below mouth of Lower Three Runs Creek, right bank. |
| S-68A | Savannah River approximately 500 yards below mouth of Lower Three Runs Creek, left bank. |
| S-68E | Savannah River approximately 500 yards below mouth of Lower Three Runs Creek, right bank. |
| S-69A | Savannah River approximately 700 yards below mouth of Lower Three Runs Creek, left bank. |

TABLE B-I cont'd

SAMPLING STATION LOCATIONS AND DESCRIPTIONS

| Station Number | Station Description |
|---|---|
| S-69E | Savannah River approximately 700 yards below mouth of Lower Three Runs Creek, right bank. |
| S-70A | Savannah River approximately 1000 yards below mouth of Lower Three Runs Creek, left bank. |
| S-70E | Savannah River approximately 100 yards below mouth of Lower Three Runs Creek, right bank. |
| S-71A | Savannah River approximately 1500 yards below mouth of Lower Three Runs Creek, left bank. |
| S-71E | Savannah River approximately 1500 yards below mouth of Lower Three Runs Creek right bank. |

## TABLE B-II

## DAILY FECAL COLIFORM BACTERIA DENSITIES AT ALL STATIONS SAMPLED

| Location | Station Number | Fecal Coliform Bacteria/100 ml | | | | |
|---|---|---|---|---|---|---|
| | | 7/6/70 | 7/7/70 | 7/8/70 | 7/9/70 | 7/10/70 |
| Industrial Canal | IC-1 | 20 | 20 | 130 | 50 | 20 |
| Industrial Canal | IC-2 | 20 | 20 | 20 | 50 | 20 |
| Industrial Canal | SI-3 | 230 | 70 | 330 | 50 | 20 |
| Industrial Canal | HG-4 | 23,000 | 17,000 | 46,000 | 23,000 | 7,900 |
| Butler Creek | BC-5 | 790 | | | | |
| Butler Creek | BC-6 | 17,000,000 | 7,900,000 | 4,900,000 | 3,300,000 | 3,300,000 |
| Ft. Gordon STP Influent | FG-7 AM | 110,000,000 | 70,000,000 | 33,000,000 | 70,000,000 | --- |
| | FG-7 PM | 110,000,000 | 79,000,000 | --- | --- | --- |
| Ft. Gordon STP Effluent | FG-8 AM | >1,600,000 | 1,100,000 | --- | 2,300,000 | --- |
| | FG-8 PM | >1,600,000 | 700,000 | 2,300,000 | --- | --- |
| Spirit Creek | SC-9 | 46,000 | 23,000 | 1,400 | 23,000 | 11,000 |
| Spirit Creek | SC-10 | 90 | 4,900 | 490 | 330 | 1,700 |
| Spirit Creek | SC-11 | 1,700 | 330 | --- | 2,200 | 330 |
| Reeds Creek | RC-12 | 50 | --- | --- | --- | 140 |
| Lake Olmstead | LO-13 | 110 | --- | --- | --- | 130 |
| Gwinnet St. Drainage Ditch | G-14 | >1,600,000 | --- | --- | --- | 17,000,000 |
| Camille Street Ditch | U-15 | 35,000,000 | --- | --- | --- | 22,000,000 |
| Oates Creek | OC-16 | 110,000 | --- | --- | --- | 4,900 |
| Rocky Creek | RO-17 | 17,000 | --- | --- | --- | 1,200,000 |
| Columbia Nitrogen - Caprolactum Plant | CN-18 | --- | --- | <20 | 7,900 | --- |
| Columbia Nitrogen - Nitrogen Plant | | --- | --- | 4,600 | 4,900 | --- |
| Butler Creek Sewage Treatment Plant | BC-19 | --- | --- | <2,000 | 1,100 | 1,100 |

**TABLE B-II cont'd**

| Location | Station Number | Fecal Coliform Bacteria/100 ml | | |
|---|---|---|---|---|
| | | 7/28/70 | 7/29/70 | 7/30/70 |
| Savannah River | S-47A | 1,700 | 2,300 | 1,700 |
| " " | S-47E | 1,700 | 1,400 | 3,300 |
| " " | S-66A | 490 | 1,700 | 2,200 |
| " " | S-66E | 1,700 | 700 | 1,100 |
| " " | S-67A | 3,300 | 2,300 | 4,600 |
| " " | S-67E | 7,000 | 2,300 | 7,000 |
| " " | S-68A | 3,300 | 3,300 | 2,800 |
| " " | S-68E | 1,300 | 2,300 | 1,700 |
| " " | S-69A | 3,300 | 3,300 | 3,300 |
| " " | S-69E | 2,300 | 790 | 3,300 |
| " " | S-70A | 1,300 | 3,300 | 1,100 |
| " " | S-70E | 3,300 | 1,300 | 1,300 |
| " " | S-71A | 1,700 | 2,300 | 1,300 |
| " " | S-71E | 4,900 | 2,800 | 13,000 |

TABLE B-II cont'd

| Location | Station Number | Fecal Coliform Bacteria/100 ml | | | | |
|---|---|---|---|---|---|---|
| | | 7/13/70 | 7/14/70 | 7/15/70 | 7/16/70 | 7/17/70 |
| Continental Can Paper Mill | CC-20 | --- | --- | 3,300 | 33,000 | --- |
| Continental Can Sludge Lagoon | | --- | --- | 49,000 | 49,000 | --- |
| Kelly Creek | KC-21 | 170 | 330 | 110 | 230 | 170 |
| Kelly Creek | KC-22 | 3,300 | 7,900 | 4,900 | 3,100 | 2,300 |
| Kelly Creek | KC-23 | 4,900 | 4,900 | 3,300 | 3,300 | 1,300 |
| Kelly Creek | KC-24 | 79,000 | >160,000 | 33,000 | 140,000 | 2,300,000 |
| Horse Creek | HC-25 | 110 | 790 | 330 | 170 | 110 |
| Graniteville Textile Mill | GM-26 | <200 | <20 | <20 | <20 | <20 |
| Horse Creek | HC-27 | <200 | <20 | 20 | <20 | <20 |
| Valchem Plant | V-28 | 110 | 3,300 | 490 | 490 | 3,300 |
| Horse Creek | HC-29 | 200 | 130 | 80 | <20 | 790 |
| Horse Creek | HC-30 | 23,000 | 54,000 | 23,000 | 33,000 | 11,000 |
| Little Horse Creek | LHC-31 | <200 | 13,000 | 330 | 490 | 230 |
| Clearwater Finishing Plant | CM-32 | <20 | <20 | <20 | <20 | <20 |
| Little Horse Creek | LHC-33 | 79,000 | 13,000 | 49,000 | 13,000 | 700 |
| Horse Creek | HC-34 | 33,000 | 23,000 | 33,000 | 7,900 | 22,000 |
| Horse Creek | HC-35 | 17,000 | 17,000 | 4,900 | 3,300 | 4,600 |
| Aiken, S.C. STP | A-36 | 7,900,000 | 7,000,000 | --- | --- | --- |
| Warrenville, S.C. STP | W-37 | 490,000 | 16,000,000 | 490,000<br>(7/12/70) | --- | --- |
| Bath Mill | B-38 | --- | --- | 3,300 | 14,000 | <20 |
| Seminole Mill | SM-39 | --- | --- | 700 | 490 | 110 |
| Kimberly Clark Company | KC-40 | --- | --- | 80 | 170 | 270 |
| Langley Pond | LP-42 | <200 | 20 | --- | --- | --- |

TABLE B-II cont'd

| Location | Station Number | Fecal Coliform Bacteria/100 ml | | | | | |
|---|---|---|---|---|---|---|---|
| | | 7/23/70 | | | 7/24/70 | | |
| | | 1000-1300 | 1400-1700 | 1800-2100 | 2200-0100 | 0200-0500 | 0600-0900 |
| North Augusta Untreated Sewage | NA-41 | 13,000,000 | 54,000,000 | 24,000,000 | 24,000,000 | 11,000,000 | 17,000,000 |

TABLE B-II cont'd

| Location | Station Number | Fecal Coliform Bacteria/100 ml | | |
|---|---|---|---|---|
| | | 7/20/70 | 7/21/70 | 7/22/70 |
| Lower Three Runs Creek | LTR-43 | 110 | 20 | 130 |
| J.P. Stevens Company | JPS-44 | 2,400,000 | 17,000,000 | 7,900,000 |
| Lower Three Runs Creek | LTR-45 | 1,700 | 13,000 | 2,300 |
| Lower Three Runs Creek | LTR-46 | 200 | 80 | 790 |

TABLE B-II cont'd

| Location | Station Number | Fecal Coliform Bacter/100 ml | | | |
|---|---|---|---|---|---|
| | | 8/1/70 | 8/2/70 | 8/3/70 | 8/4/70 |
| Savannah River | S-53A | 4,600 | 2,300 | 13,000 | 23,000 |
| " " | S-53E | 54,000 | 33,000 | 17,000 | 23,000 |
| " " | S-58A | 160,000 | 11,000 | 4,600 | 7,900 |
| " " | S-58E | 24,000 | 9,400 | 3,300 | 23,000 |
| " " | S-73A | 50 | 20 | 170 | 20 |
| " " | S-73E | <20 | 70 | 130 | 20 |
| " " | S-74A | 490 | 92,000 | >160,000 | 3,300 |
| " " | S-74C | 700 | 7,900 | 460 | 4,900 |
| " " | S-74E | 35,000 | 23,000 | 7,000 | 130,000 |
| " " | S-77A | 33,000 | 2,100 | 4,900 | 13,000 |
| " " | S-77C | 92,000 | 4,900 | 7,900 | 22,000 |
| " " | S-77E | 54,000 | 7,000 | 23,000 | 130,000 |
| " " | S-83A | 130,000 | 33,000 | 4,900 | 7,900 |
| " " | S-83C | 130,000 | 49,000 | 33,000 | 70,000 |
| " " | S-83E | 110,000 | 240,000 | 70,000 | 350,000 |
| " " | S-86A | 240,000 | 79,000 | 49,000 | 79,000 |
| " " | S-86E | 130,000 | 33,000 | 13,000 | 70,000 |
| " " | S-88A | 79,000 | 130,000 | 79,000 | 49,000 |
| " " | S-88C | 94,000 | 79,000 | 70,000 | 33,000 |
| " " | S-88E | 350,000 | 130,000 | 28,000 | 49,000 |

## TABLE B-III

## SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

| | | Fecal Coliform Bacteria/100 ml | | | | |
|---|---|---|---|---|---|---|
| Location | Station | Maximum | Minimum | Arithmetic Mean | Geometric Mean | Number of Samples |
| Industrial Canal | IC-1 | 130 | 20 | 48 | 35 | 5 |
| Industrial Canal | IC-2 | 50 | 20 | 26 | 24 | 5 |
| Industrial Canal | SI-3 | 330 | 20 | 120 | 69 | 5 |
| Industrial Canal | HG-4 | 46,000 | 7,900 | 23,000 | 20,000 | 5 |
| Butler Creek | BC-5 | 1,300 | 230 | 600 | 480 | 5 |
| Butler Creek | BC-6 | 17,000,000 | 3,300,000 | 7,300,000 | 5,900,000 | 5 |
| Fort Gordon STP Influent | FG-7 | 110,000,000 | 33,000,000 | 79,000,000 | 73,000,000 | 6 |
| Fort Gordon STP Effluent | FG-8 | 2,300,000 | 700,000 | 1,600,000 | 1,500,000 | 6 |
| Spirit Creek | SC-9 | 46,000 | 1,400 | 21,000 | 13,000 | 5 |
| Spirit Creek | SC-10 | 4,900 | 90 | 1,500 | 660 | 5 |
| Spirit Creek | SC-11 | 2,200 | 330 | 1,100 | 800 | 4 |
| Reed Creek | RC-12 | 140 | 50 | 95 | 84 | 2 |
| Lake Olmstead | LO-13 | 130 | 110 | 120 | 120 | 2 |

## TABLE B-III

## SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

| Location | Station | Fecal Coliform Bacteria/100 ml Maximum | Minimum | Arithmetic Mean | Geometric Mean | Number of Samples |
|---|---|---|---|---|---|---|
| Gwinnett St. Drainage | G-14 | 17,000,000 | >1,600,000 | | | 2 |
| Camille St. Ditch | U-15 | 35,000,000 | 22,000,000 | 29,000,000 | 28,000,000 | 2 |
| Oates Creek | OC-16 | 110,000 | 4,900 | 57,000 | 23,000 | 2 |
| Rocky Creek | RO-17 | 1,200,000 | 200 | 410,000 | 16,000 | 3 |
| Columbia Nitrogen Plant | | 4,900 | 4,600 | 4,800 | 4,800 | 2 |
| Columbia Nitrogen Caprolactum Plant | CN-18 | 7,900 | < 20 | 4,000 | 400 | 2 |
| Butler Creek STP Effluent | BC-19 | <2,000 | 11,000 | 14,000 | 1,300 | 3 |
| Continental Can | CC-20 | 33,000 | 3,300 | 18,000 | 10,000 | 2 |
| Continental Can Sludge Lagoon Effluent | | 49,000 | 49,000 | 49,000 | 49,000 | 2 |
| Kelly Creek | KC-21 | 330 | 110 | 200 | 190 | 5 |

## TABLE B-III

## SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

| Location | Station | Fecal Coliform Bacteria/100 ml<br>Maximum | Minimum | Arithmetic Mean | Geometric Mean | Number of Samples |
|---|---|---|---|---|---|---|
| Kelly Creek | KC-22 | 7,900 | 2,300 | 4,300 | 3,900 | 5 |
| Kelly Creek | KC-23 | 4,900 | 1,300 | 3,500 | 3,200 | 5 |
| Kelly Creek | KC-24 | 2,300,000 | 33,000 | 540,000 | 170,000 | 5 |
| Horse Creek | HC-25 | 790 | 110 | 300 | 220 | 5 |
| Horse Creek | HC-27 | < 200 | <20 | <20 | <20 | 5 |
| Horse Creek | HC-29 | 790 | <20 | 240 | 130 | 5 |
| Horse Creek | HC-30 | 54,000 | 11,000 | 29,000 | 25,000 | 5 |
| Horse Creek | HC-34 | 33,000 | 7,900 | 24,000 | 21,000 | 5 |
| Horse Creek | HC-35 | 17,000 | 3,300 | 9,400 | 7,400 | 5 |
| Langley Pond | LP-42 | <200 | 20 | | | 2 |
| Little Horse Creek | LHC-31 | 13,000 | <200 | 2,900 | 630 | 5 |
| Little Horse Creek | LHC-33 | 79,000 | 700 | 31,000 | 14,000 | 5 |
| Graniteville Mill | GM-26 | <200 | <20 | <20 | <20 | 5 |

## TABLE B-III

## SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

| Location | Station | Fecal Coliform Bacteria/100 ml Maximum | Minimum | Arithmetic Mean | Geometric Mean | Number of Samples |
|---|---|---|---|---|---|---|
| Valchem Mill | V-28 | 3,300 | 110 | 1,500 | 780 | 5 |
| Clearwater Finishing Plant | CM-32 | <20 | <20 | <20 | <20 | 5 |
| Aiken, S.C. STP Effluent | A-36 | 7,900,000 | 7,000,000 | 7,500,000 | 7,400,000 | 2 |
| Warrenville, S.C. STP Effluent | W-37 | >16,000,000 | 490,000 | 8,200,000 | 2,800,000 | 3 |
| Bath Mill | B-38 | 14,000 | <20 | 5,800 | 970 | 3 |
| Seminole Mill | SM-39 | 700 | 110 | 430 | 340 | 3 |
| Kimberly Clark | KC-40 | 270 | 80 | 170 | 150 | 3 |
| North Augusta, S.C. Sewage | NA-41 | 54,000,000 | 11,000,000 | 24,000,000 | 21,000,000 | 6 |
| Lower Three Runs Creek | LTR-43 | 130 | 20 | 87 | 66 | 3 |
| Lower Three Runs Creek | LTR-45 | 13,000 | 1,700 | 5,700 | 3,700 | 3 |
| Lower Three Runs Creek | LTR-46 | 790 | 80 | 360 | 230 | 3 |

## TABLE B-III

## SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

| | | Fecal Coliform Bacteria/100 ml | | | | |
|---|---|---|---|---|---|---|
| Location | Station | Maximum | Minimum | Arithmetic Mean | Geometric Mean | Number of Samples |
| J.P. Stevens Plant | JPS-44 | 17,000,000 | 2,400,000 | 9,100,000 | 6,900,000 | 3 |
| Savannah River | S-50-A | 130 | 20 | 48 | 35 | 5 |
| Savannah River | S-73A | 170 | 20 | 65 | 43 | 4 |
| Savannah River | S-73E | 130 | < 20 | 60 | 44 | 4 |
| Savannah River | S-74A | > 160,000 | 490 | 64,000 | 12,000 | 4 |
| Savannah River | S-74C | 7,900 | 460 | 3,500 | 1,900 | 4 |
| Savannah River | S-74E | 130,000 | 7,000 | 49,000 | 29,000 | 4 |
| Savannah River | S-53A | 23,000 | 2,300 | 11,000 | 7,500 | 4 |
| Savannah River | S-53E | 54,000 | 17,000 | 32,000 | 29,000 | 4 |
| Savannah River | S-77A | 33,000 | 2,100 | 13,000 | 8,000 | 4 |
| Savannah River | S-77C | 92,000 | 4,900 | 32,000 | 17,000 | 4 |
| Savannah River | S-77E | 130,000 | 7,000 | 54,000 | 33,000 | 4 |
| Savannah River | S-58A | 160,000 | 46,000 | 46,000 | 16,000 | 4 |
| Savannah River | S-58E | 24,000 | 3,300 | 15,000 | 11,000 | 4 |

TABLE B-III

SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

| Location | Station | Fecal Coliform Bacteria/100 ml | | | | Number of Samples |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Arithmetic Mean | Geometric Mean | |
| Savannah River | S-83A | 130,000 | 4,900 | 44,000 | 20,000 | 4 |
| Savannah River | S-83C | 130,000 | 33,000 | 71,000 | 62,000 | 4 |
| Savannah River | S-83E | 350,000 | 70,000 | 190,000 | 160,000 | 4 |
| Savannah River | S-86A | 240,000 | 49,000 | 110,000 | 93,000 | 4 |
| Savannah River | S-86E | 130,000 | 13,000 | 62,000 | 44,000 | 4 |
| Savannah River | S-88A | 130,000 | 49,000 | 84,000 | 79,000 | 4 |
| Savannah River | S-88C | 94,000 | 33,000 | 69,000 | 64,000 | 4 |
| Savannah River | S-88E | 350,000 | 28,000 | 140,000 | 89,000 | 4 |
| Savannah River | S-47A | 2,300 | 1,700 | 1,900 | 1,900 | 3 |
| Savannah River | S-47E | 3,300 | 1,400 | 2,100 | 2,000 | 3 |
| Savannah River | S-66A | 2,200 | 490 | 1,500 | 1,200 | 3 |
| Savannah River | S-66E | 1,700 | 700 | 1,200 | 1,100 | 3 |
| Savannah River | S-67A | 4,600 | 2,300 | 3,400 | 3,300 | 3 |
| Savannah River | S-67E | 7,000 | 2,300 | 5,400 | 4,800 | 3 |

## TABLE B-III

## SUMMARY OF FECAL COLIFORM BACTERIA DATA FOR THE ENTIRE STUDY

| Location | Station | Fecal Coliform Bacteria/100 ml | | | | Number of Samples |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Arithmetic Mean | Geometric Mean | |
| Savannah River | S-68A | 3,300 | 2,800 | 3,100 | 3,100 | 3 |
| Savannah River | S-68E | 2,300 | 1,300 | 1,800 | 1,700 | 3 |
| Savannah River | S-69A | 3,300 | 3,300 | 3,300 | 3,300 | 3 |
| Savannah River | S-69E | 3,300 | 790 | 2,100 | 1,800 | 3 |
| Savannah River | S-70A | 3,300 | 1,100 | 1,900 | 1,700 | 3 |
| Savannah River | S-70E | 3,300 | 1,300 | 2,000 | 1,800 | 3 |
| Savannah River | S-71A | 2,300 | 1,300 | 1,800 | 1,700 | 3 |
| Savannah River | S-71E | 13,000 | 2,800 | 6,900 | 5,600 | 3 |

## TABLE B-IV

### THE TEN MOST FREQUENTLY REPORTED SALMONELLA SEROTYPES DURING JULY 1970 [1]

| Human Sources | | Nonhuman Sources | |
|---|---|---|---|
| Rank | Serotypes | Rank | Serotypes |
| 1 | Salmonella typhi-murium* | 1 | Salmonella typi-murium* |
| 2 | S. enteritidis | 2 | S. heidelberg |
| 3 | S. newport | 3 | S. anatum |
| 4 | S. heidelberg | 4 | S. schwarzengrund |
| 5 | S. infantis | 5 | S. infantis |
| 6 | S. saint-paul | 6 | S. saint-paul |
| 7 | S. thompson | 7 | S. montevideo |
| 8 | S. blockley | 8 | S. worthington |
| 9 | S. derby | 9 | S. san-diego |
| 10 | S. montevideo | 10 | S. indiana |

*Includes variety copenhagen

[1] According to Report No. 100, Center for Disease Control Salmonella Surveillance for July, 1970.

# TABLE B-V

## LIST OF SAMPLING SITES FOR SALMONELLA AND THE SEROTYPES RECOVERED

| Stream | Station | Salmonella Serotypes Isolated |
|---|---|---|
| Industrial Canal | IC-2 | S. muenchen, S. mississippi, S. give |
| Industrial Canal | HG-4 | S. st. paul, S. havana, S. senftenberg |
| Butler Creek | BC-5 | S. sieburg |
| Butler Creek | BC-6 | S. simsbury, S. anatum, S. cubana, S. thompson |
| Spirit Creek | FG-8 | S. cubana, S. binza, S. minnesota |
| Spirit Creek | SC-10 | S. rubislaw, S. muenchen, S. mississippi |
| Spirit Creek | SC-11 | S. madelia |
| Horse Creek | HC-27 | None detected |
| Horse Creek | HC-30 | S. montivideo |
| Horse Creek | HC-35 | None detected |
| Little Horse Creek | LHC-31 | S. rubislaw |
| Little Horse Creek | LHC-33 | None detected |
| Kelly Creek | A-36 | S. muenchen |
| Kelly Creek | W-37 | S. heidelberg, S. typhimurium var. copenhagen |
| Lower Three Runs Creek | JPS-44 | None detected |
| Lower Three Runs Creek | LTR-46 | None detected |
| Savannah River | S-50 | None detected |
| Savannah River | S-73A | S. newport, S. panama |
| Savannah River | S-51E | S. javiana, S. muenchen, S. panama, S. montivedeo, S. oranienburg |
| Savannah River | NA-41 | S. panama |
| Savannah River | S52-L | S. muenchen, S. typhimurium, S. mississippi, S. newport |

## TABLE B-V cont'd

## LIST OF SAMPLING SITES FOR SALMONELLA AND THE SEROTYPES RECOVERED

| Stream | Station | Salmonella Serotypes Isolated |
|---|---|---|
| Savannah River | S-78-A | S. panama |
| Savannah River | S-78-B | S. muenchen, S. heidelberg |
| Savannah River | S-82 | S. typhimurium |
| Savannah River | S-87 | S. muenster, S. newport, S. cubana, S. typhimurium var. copenhagen |
| Savannah River | S-91 | S. typhimurium, S. muenchen, S. newport, S. muenster, S. derby, S. heidelberg |
| Savannah River | S-47A | S. muenchen, S. typhimurium, S. typhimurium var. copenhagen |
| Savannah River | S-48 | S. typhimurium var. copenhagen |
| Savannah River | S-70A | S. typhimurium, S. halmstad, $E_1$ eh, $z_{48}$ |

## TABLE B-VI

## COMPARISONS OF MEAN FECAL COLIFORM BACTERIA LEVELS AT SELECTED SITES THAT ALSO HAD *SALMONELLA* PRESENT

| Stream | Station | Fecal Coliform Bacteria/100ml[1] | Geometric Mean Fecal Coliform Bacteria/100 ml | Number of Salmonella Serotypes Isolated |
|---|---|---|---|---|
| Industrial Canal | IC-2 | 20 | 24 | 3 |
| Industrial Canal | HG-4 | 7,900 | 20,000 | 3 |
| Butler Creek | BC-5 | 230 | 480 | 1 |
| Butler Creek | BC-6 | 3,300,000 | 5,900,000 | 4 |
| Spirit Creek | FG-8 | 2,300,000 | 1,500,000 | 3 |
| Spirit Creek | SC-10 | 1,700 | 660 | 3 |
| Spirit Creek | SC-11 | 330 | 800 | 1 |
| Horse Creek | HC-27 | <20 | <20 | 0 |
| Horse Creek | HC-30 | 11,000 | 25,000 | 1 |
| Horse Creek | HC-35 | 4,600 | 7,400 | 0 |
| Little Horse Creek | LHC-31 | 230 | 630 | 1 |
| Little Horse Creek | LHC-33 | 700 | 14,000 | 0 |
| Kelly Creek | A-36 | 7,000,000 | 7,400,000 | 3 |
| Kelly Creek | W-37 | >16,000,000 | 2,800,000 | 2 |
| Savannah River | S-50 | 20 | 35 | 0 |
| Savannah River | S-73A | 20 | 43 | 2 |
| Savannah River | S-51E | 130,000[2] | 29,000[2] | 5 |
| Savannah River | NA-41 | 17,000,000 | 21,000,000 | 1 |
| Savannah River | S-52-L | — | — | 4 |
| Savannah River | S-78-A | 13,000[3] | 8,000[3] | 1 |
| Savannah River | S-78-B | 22,000[3] | 17,000[3] | 2 |
| Savannah River | S-82 | 350,000[4] | 160,000[4] | 1 |

## TABLE B-VI

## COMPARISONS OF MEAN FECAL COLIFORM BACTERIA LEVELS AT SELECTED SITES THAT ALSO HAD SALMONELLA PRESENT

| Stream | Station | Fecal Coliform Bacteria/100 ml 1/ | Geometric Mean Fecal Coliform Bacteria/100 ml | Number of Salmonella Serotypes Isolated |
|---|---|---|---|---|
| Savannah River | S-87 | 49,000 5/ | 89,000 5/ | 4 |
| Savannah River | S-91 | -- | -- | 6 |
| Savannah River | S-47-A | 1,700 | 1,900 | 3 |
| Savannah River | S-48 | -- | -- | 1 |
| Savannan River | S-70-A | 1,100 | 1,700 | 3 |
| Lower Three Runs Creek | JPS-44 | 7,900,000 | 6,900,000 | 0 |
| Lower Three Runs Creek | LTR-46 | 790 | 230 | 0 |

---

1/ Fecal coliform bacteria density at station on day of Salmonella swab collection.

2/ No fecal coliform bacteria determinations were made at Station S-51E. The fecal coliform bacteria density as measured at Station S-74E, located approximately 300 yards downstream from Station S-51E, was used in the table for comparative purposes.

3/ No fecal coliform bacteria determinations were made at Station S-78-A and S-78-B. The fecal coliform bacteria density, as measured at Stations S-77-A and S-77-B, located approximately 200 yards upstream from Stations S-78-A and S-78-B, were used in the table for comparative purposes.

4/ No fecal coliform bacteria determinations were made at Station S-82. The fecal coliform bacteria density as measured at Station S-83-E, located approximately 200 yards downstream from Station S-82, was used in the table for comparative purposes.

5/ No fecal coliform bacteria determinations were made at Station S-87. The fecal coliform bacteria density as measured at Station S-88-E, located approximately 200 yards downstream from Station S-87, was used in the table for comparative purposes.

## TABLE B-VII

## IDENTIFICATION SCHEME FOR SALMONELLA SUSPECTS

Suspect colony (picked from differential plate)

Triple Sugar Iron Agar (TSI)

Alkaline slant and acid butt with or without $H_2S$

Acid slant and butt; Alkaline slant and butt - DISCARDED

Urease Production

Positive
DISCARDED

Negative

Cytochrome Oxidase

Positive
DISCARDED

Negative

Polyvalent 'O' Antisera

Positive

Negative
DISCARDED

Lactose; Sodium Malonate; Potassium Cyanide

Positive
DISCARDED

Negative

Lysine decarboxylase; Citrate

Negative
DISCARD

Positive

Serological Identification

Verification by NCDC

# APPENDIX C

## BIOLOGICAL STUDIES
## MIDDLE REACH SAVANNAH RIVER

by

Lee Tebo

## TABLE OF CONTENTS

Title . . . Page No.

SUMMARY AND CONCLUSIONS . . . . . . . . . . . . . . . . . . . C-1
INTRODUCTION . . . . . . . . . . . . . . . . . . . . . . . . C-5
TRIBUTARY SURVEY . . . . . . . . . . . . . . . . . . . . . . C-9
SAVANNAH RIVER SURVEY . . . . . . . . . . . . . . . . . . . C-15
REFERENCES . . . . . . . . . . . . . . . . . . . . . . . . . C-21
APPENDICES . . . . . . . . . . . . . . . . . . . . . . . . .
    Appendix C-I, Biological Methods . . . . . . . . . . . . . C-1-1
    Appendix C-II, Tabular Summaries of Biological Data . . C-1-6

## LIST OF TABLES

| Number | Title | Page No. |
|---|---|---|
| C-1 | LEVELS OF CARBON AND CHROMIUM FOUND IN SEDIMENTS FROM THE SAVANNAH RIVER AND TRIBUTARIES . . | C-11 |

## LIST OF FIGURES

| Number | Title | Follows Page No. |
|---|---|---|
| C-1 | CHEMICAL AND BIOLOGICAL SAMPLING STATIONS SAVANNAH RIVER-AUGUSTA AREA . . . . . . | C-6 |
| C-2 | CHEMICAL AND BIOLOGICAL SAMPLING STATIONS SAVANNAH RIVER-HORSE CREEK AREA . . . . . . | C-6 |
| C-3 | CHEMICAL AND BIOLOGICAL SAMPLING STATIONS SAVANNAH RIVER-LOWER THREE RUNS CREEK AREA . . . . . . | C-6 |
| C-4 | SAVANNAH RIVER STUDY AREA GEORGIA-SOUTH CAROLINA . . | C-9 |
| C-5 | MEAN EQUITABILITY COMPONENTS (E) OF SPECIES DIVERSITY OF MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER WITH ARTIFICAL SUBSTRATE SAMPLERS . . . . . | C-19 |
| C-6 | DISSOLVED OXYGEN LEVELS OVER A 24-HOUR PERIOD AT THREE STATIONS ON THE "UPPER SECTION" OF THE SAVANNAH RIVER . . . . | C-20 |

# MIDDLE REACH SAVANNAH RIVER
# BIOLOGICAL STUDIES

## Summary and Conclusions:

Biological studies consisted of sampling of the vascular plants, plankton, periphyton and macroinvertebrates at stations above and below waste sources on the Savannah River and major tributaries in a 75 mile reach of river between North Augusta, South Carolina and Allendale, South Carolina. Concurrent with the biological studies data were collected on the diurnal cycle of oxygen in the Savannah River and on the levels of carbon and chromium in the sediments. Tributaries studied included Horse Creek, Butler Creek, Spirit Creek and Lower Three Runs Creek.

The results of these studies may be summarized as follows:

(1) Kelly Creek, a tributary of Horse Creek, is degraded by domestic wastes originating from Aiken, South Carolina and Graniteville, South Carolina and sludge deposits were present in this creek below the outfalls of the sewage treatment plants from the above towns.

(2) Little Horse Creek, a tributary of Horse Creek, is "grossly polluted" by domestic and industrial wastes originating in the vicinity of Clearwater, South Carolina. Sludge deposits in this creek contained 163 ppm of chromium.

(3) Horse Creek for a distance of at least 1.6 miles from its mouth was a "dead" stream and contained no living macroinvertebrate organisms. Sludge deposits in this creek contained 990 ppm of chromium, a concentration many fold higher than that reported to be toxic to aquatic life, including fish.

(4) Butler Creek, in its upper reaches, is affected by low levels of organic wastes and below the ditches draining the southern part of Augusta, Georgia it is polluted by organic wastes sufficient to deplete the oxygen. In the lower section, just above its junction with the Savannah River, the bottom of Butler Creek is covered with active sludge deposits supporting a dense population of sludge worms.

(5) Spirit Creek, just above Continental Can, was subject to low levels of organic wastes from Fort Gordon and below Continental Can was "grossly polluted" by organic wastes in quantities sufficient to deplete the oxygen. Black liquor from Continental Can severely reduced the transparency of this Creek.

(6) Lower Three Runs Creek was "grossly polluted" by organic wastes from J. P. Stevens and sludge deposits in the lower reach of this creek contained an average of 10.7 per cent carbon.

(7) During July, 1970 the measured flow from all known waste sources in the 75 mile reach of the Savannah River studied was approximately 110 cubic feet per second (cfs). Average flow of the Savannah River during July at Savannah Bluff Lock and Dam was approximately 6120 cfs providing a 60:1 dilution for wastes entering the river over the 75 mile reach. Because of the high rate of waste dilution after mixing, the effects of individual waste sources on the river are subtle and difficultly measurable.

For a distance of at least 1000 yards below the mouth of Horse Creek the east central portion of the river bottom was coated with slimy fibrous sludge deposits, samples of which contained 5.8 per cent carbon. These sludge deposits contained measured chromium concentrations of 670 ppm which appeared to be having a teratogenic effect on the midge larva Chironomus attenuatus; the only living macroinvertebrate inhabitant of the deposits. Some chromium was contributed from the industrial canal with concentrations as high as 32 ppm found in sediments immediately above Horse Creek.

Dissolved oxygen below 5.0 ppm was not detected during the period of this study, however a diurnal study of dissolved oxygen showed that wastes originating in the reach of river between Hawk's Gully and Horse Creek were of sufficient magnitude to significantly reduce the oxygen assets in this "upper section" of the river.

The cumulative effects of enrichment from organic wastes discharged to the river was reflected in the standing crops of plankton and periphyton which increased in total quantity and contained increasing amounts of filamentous green and bluegreen algae at downstream stations. The increased standing crops and decrease in diversity of macroinvertebrates inhabiting artificial substrate samplers were further evidence of an enriched, semi-healthy environment. The minimum diversity was found at stations immediately below Spirit Creek which were subject to the cumulative effects of upstream wastes originating in the states of Georgia and South Carolina. As measured by the diversity of the macroinvertebrate community the river never fully recovers before reaching Lower Three Runs Creek, the lowermost source of pollution. Below Lower

Three Runs Creek the macroinvertebrate population is again reduced to a level indicative of a semi-healthy environment.

On the basis of the biological data collected during this study the entire reach of the Savannah River from Augusta, Georgia downstream to Johnson's Landing would be classified as semi-healthy. Additional stress from further inputs of oxygen demanding wastes or toxic materials could have potentially catastrophic effects on the river and its biota.

# MIDDLE REACH SAVANNAH RIVER BIOLOGICAL STUDIES

### Introduction:

Since 1951 the Philadelphia Academy of Science, under contract to the Atomic Energy Division of E. I. duPont Nemours and Company, has been conducting biological studies of the Savannah River.

In a summary analysis of 20 years of detailed study (4) of all components of the aquatic flora and fauna the Philadelphia Academy found that since 1951-1952, at four stations in the reach of river between Savannah Bluff Lock and Dam and Highway 301 bridge, there has been an increase in the mineralized nutrient load with a concomitant decrease in diversity of organisms and a change in the more common species. This same report cited evidence of toxic pollution occurring in several instances between 1965 and 1968. The report also mentions evidence of pollution to Lower Three Runs which has affected the Savannah River downstream to Allendale bridge.

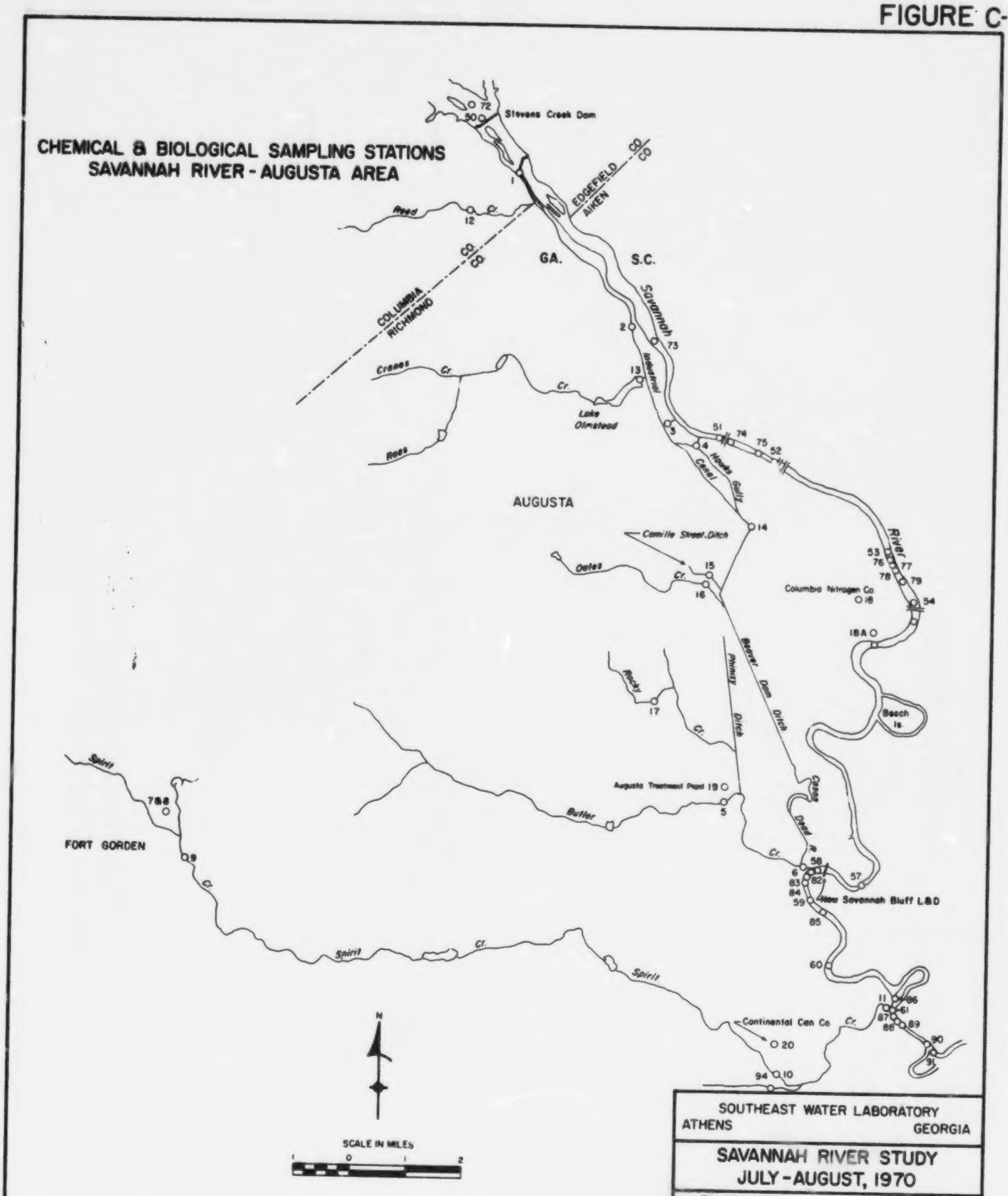
The Institute of Paper Chemistry, under contract to the Continental Can Company has since 1959 conducted studies of the Savannah River from just above the Savannah Bluff Lock and Dam (river mile 188) downstream to river mile 149. The Institue of Paper Chemistry studies were based primarily on an evaluation of bottom dwelling macroinvertebrates by comparing the presence of tolerant and intolerant genera. A summary of these data for the period 1959-1965 (2) classified all but one Savannah River station as balanced. Stations at the mouth of Butler Creek were classified as polluted.

During the early spring of 1967 the southeast region of the Federal Water Quality Administration conducted cursory studies of the macroinvertebrates at stations on Little Horse Creek, Horse Creek, Kelly Creek, Butler Creek, Spirit Creek and the Savannah River from Augusta, Georgia downstream to Silver Bluff Landing (river mile 174). This study(5) classified the lower reaches of Horse Creek, Little Horse Creek, Butler Creek and Spirit Creek as "grossly polluted". Inadequate data were available to categorize the condition of stations in the Savannah River proper.

During the late summer and early fall of 1970 the Federal Water Quality Administration conducted studies of the fauna and flora at stations on streams tributary to the Savannah River including Little Horse Creek, Kelly Creek, Horse Creek, Spirit Creek, Butler Creek and Lower Three Runs Creek and at stations in the Savannah River from the North Augusta, South Carolina water intake downstream to Johnson's Landing which is near river mile 125 and six miles upstream from Highway 301 bridge. These studies were designed to determine the effects of waste sources entering the tributaries on the biota of the tributaries plus the individual and cumulative effects of all waste sources on the biological characteristics of the Savannah River proper.

Sampling stations are shown on Figures 1, 2 and 3 and described in Appendix III.

FIGURE C-



CHEMICAL & BIOLOGICAL SAMPLING STATIONS
SAVANNAH RIVER - AUGUSTA AREA

72
50
Stevens Creek Dam
1
EDGEFIELD CO
AIKEN CO
Reed
12
Cr.
COLUMBIA CO
RICHMOND CO
GA.
S.C.
Savannah
2
73
Industrial
Cranes
Cr.
Cr.
13
Lake Olmstead
Rees
3
4
51
74
75
52
Canal
Hawks Gully
AUGUSTA
14
Camille Street Ditch
River
53
76
77
78
79
Columbia Nitrogen Co
18
54
18A
Oates
Cr.
15
16
Beaver Dam Ditch
Phinizy Ditch
Rocky
17
Cr.
Beech Is.
Spirit
7B8
FORT GORDEN
9
Cr.
Augusta Treatment Plant 19
5
Butler
Cr.
Dead R.
Cross
58
6
83
82
84
59
57
New Savannah Bluff L&D
85
Spirit
Cr.
Spirit
60
11
86
61
87
88
89
Continental Can Co
Cr.
20
90
91
94
10
N
SCALE IN MILES
1
0
1
2

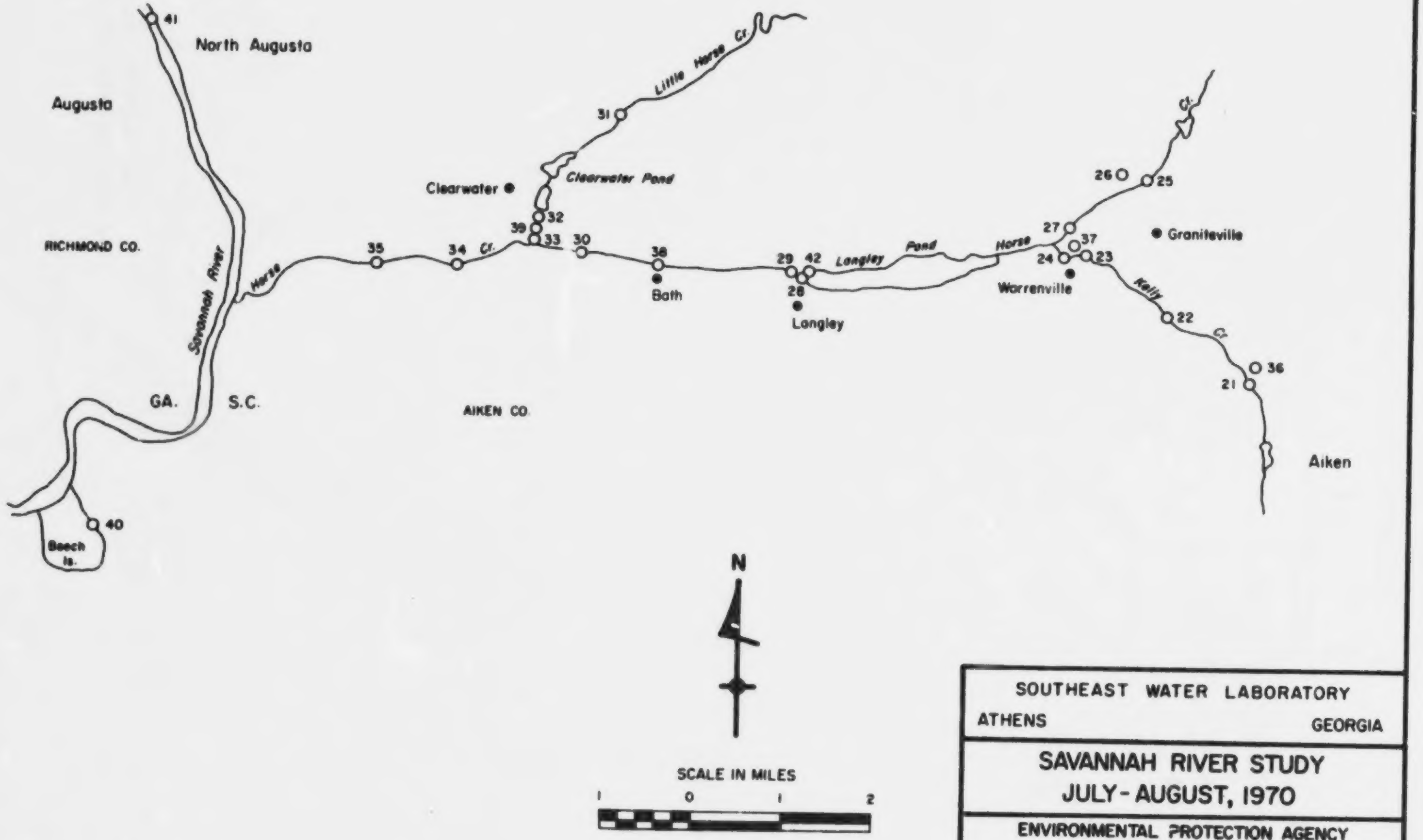
SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE C-2

## CHEMICAL & BIOLOGICAL SAMPLING STATIONS SAVANNAH RIVER-HORSE CREEK AREA


41
North Augusta
Augusta
RICHMOND CO.
Savannah River
Horse
GA.
S.C.
40
Beech Is.
AIKEN CO.
35
34
Cr.
Clearwater
39
32
33
30
Clearwater Pond
31
Little Horse Cr.
38
Bath
29
42
28
Longley
Longley Pond
Horse
27
37
24
23
Warrenville
26
25
Cr.
Graniteville
Kelly
22
Cr.
36
21
Aiken
N
SCALE IN MILES
1
0
1
2

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JULY-AUGUST, 1970

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WATER QUALITY OFFICE
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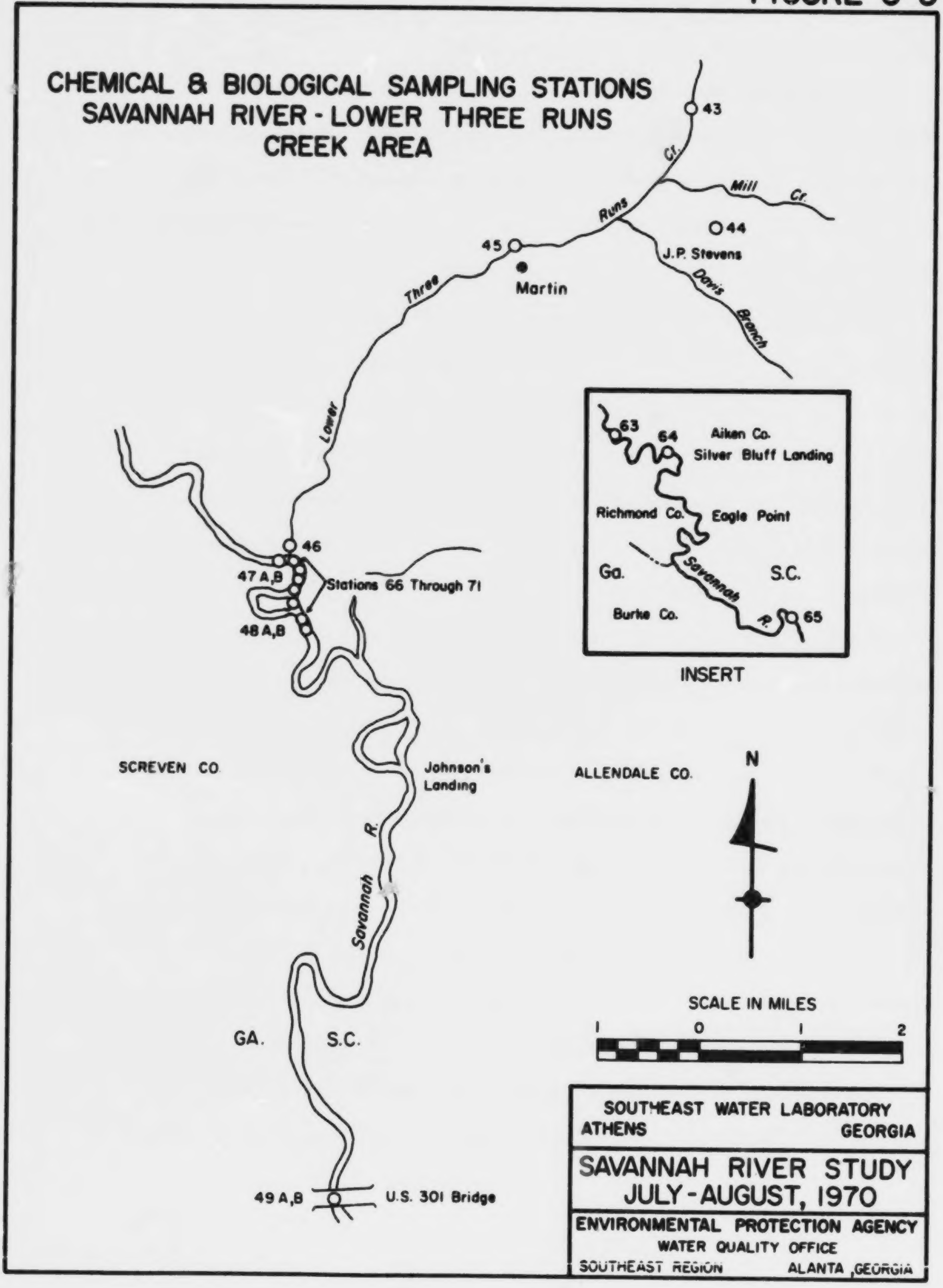
FIGURE C-3



CHEMICAL & BIOLOGICAL SAMPLING STATIONS
SAVANNAH RIVER - LOWER THREE RUNS
CREEK AREA

43
Cr.
Mill Cr.
Runs
44
45
J.P. Stevens
Davis Branch
Martin
Three
Lower
46
47 A,B
Stations 66 Through 71
48 A,B
63
64
Aiken Co.
Silver Bluff Landing
Richmond Co.
Eagle Point
Ga.
Savannah R.
S.C.
Burke Co.
65
INSERT
SCREVEN CO.
Johnson's Landing
ALLENDALE CO.
N
Savannah R.
SCALE IN MILES
1
0
1
2
GA.
S.C.
49 A,B
U.S. 301 Bridge

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY-AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ALANTA ,GEORGIA

Studies included an evaluation of plankton, periphyton and macroinvertebrate communities at river and tributary stations utilizing methods described in Appendix I . Based on characteristics of the flora and fauna various reaches of the Savannah River and tributaries were categorized as follows:

Healthy - Supports a diverse but often sparse community of attached algae and macroinvertebrates including genera and species known to be intolerant of even moderate levels of organic pollution. "Equitability" (8) of distribution of individuals among the species from quantitative samples of the community of macroinvertebrates is greater than 0.6 and often approaches 1.0. The environment would be considered clean with no organic or toxic pollutants present.

Semi-healthy - Supports a diverse and abundant community of attached algae, bacteria, fungi and macroinvertebrates but forms known to be sensitive to even low levels of organic pollution are scarce or absent. Standing crop of macroinvertebrates is usually high and some forms may dominate the population with a concomitant reduction in equitability which usually ranges between 0.3 and 0.6. This type of community of lotic organisms serves as a warning that the environment is borderline and subject to external stress. Added increments of organic materials can very quickly result in polluted conditions.

Polluted - Supports a community with a large standing crop of a few species of algae, fungi, bacteria and macroinvertebrates. Community of aufwuchs (attachment materials) is often dominated by sewage fungus with a community of macroinvertebrates comprised of forms insensitive to or independent of frequent depressions of the dissolved oxygen. Equitability is severely reduced ranging from 0.1 to 0.3. This environment is subject to high levels of organic pollutants and/or chronic (sublethal) levels of toxicants.

Grossly Polluted - This is an environment subject to high and continuing levels of organic pollution such that septic conditions are created and/or an environment subject to acutely toxic pollutants.

In the case of continuously septic conditions created by excess organic wastes the "aufwuchs" may be comprised almost wholly of "sewage fungus" and the macroinvertebrate community of only one or two species of macroinvertebrates which may be present in tremendous numbers. In the case of toxic materials there may be no forms of macroinvertebrates present, or in rare cases a species may be present that is tolerant of the particular type of toxicant being discharged.

The above arbitrary classifications apply primarily to lotic (flowing) waters and may be modified by physical characteristics of the habitat such as substrate, velocity and depth. Interpretations of qualitative data must be based on careful and intensive sampling of all available habitats and the validity of interpretation is enhanced if data from similar unpolluted control stations are available.

Data from artificial substrates reduce the effect of confounding factors such as substrate and depth and provide an objective appraisal of the macroinvertebrates. Artificial substrate data must however be supplemented by information on the characteristics of the natural substrate in the stream and the effect of waste materials thereon.

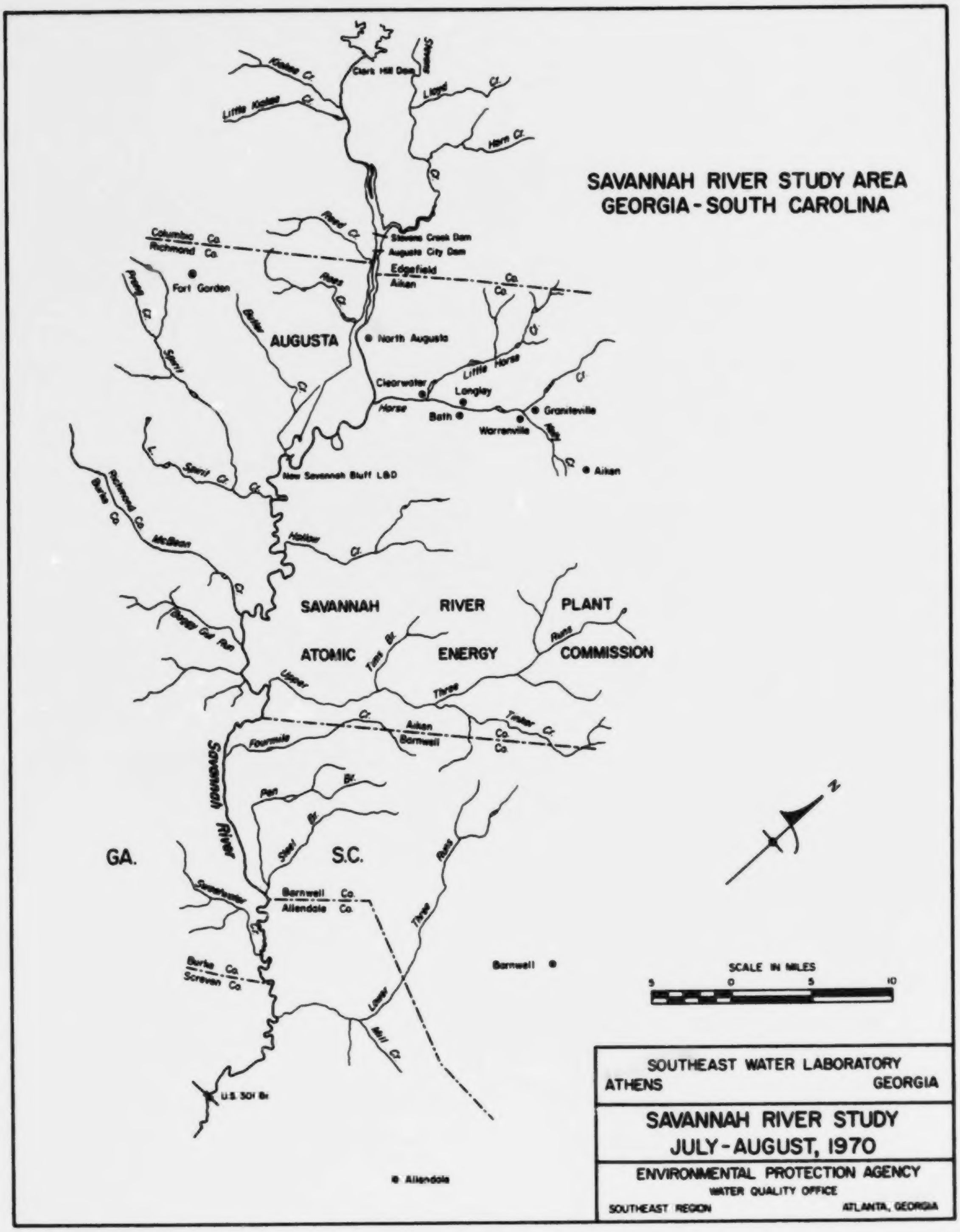
**Tributary Survey:**

In the reach of Savannah River studied there were four major tributaries known to be subject to significant amounts of industrial and municipal pollution. In downstream order these tributaries included Horse Creek, Butler Creek, Spirit Creek and Lower Three Runs Creek (Fig. 4 ). The physical characteristics and biota of all tributary stations are presented in Appendix III.

Horse Creek drains an area of South Carolina immediately south of North Augusta, South Carolina and empties into the Savannah River at mile 197.4. In addition to municipalities and industries discharging directly into Horse Creek there were two tributaries--Kelly Creek and Little Horse Creek--that received significant quantities of wastes which ultimately reached Horse Creek (Fig. 2 and section on waste sources).

Kelly Creek originates near Aiken, South Carolina and flows in a northwesterly direction to its junction with Horse Creek near Graniteville, South Carolina. Kelly Creek, in the area studied, was a shallow (1-2 feet maximum depth) swiftly flowing, sandy-bottomed stream ranging from 15 feet in width at the upper station (KC-21) to 25 feet in width at the downstream station (KC-24). Sludge deposits were appareent at stations KC-22 and KC-24 and sediment samples revealed a carbon content of 4.1 and 3.0 per cent respectively at these two stations (Table 1). Sediments from control station KC-21 contained only 0.2 per cent carbon. The fauna collected at all stations show that, even at the upper control station, Kelly Creek is subject to moderate levels of organic pollution (Appendix II). Station KC-21 was established as a control and was

FIGURE C–4


Clark Hill Dam
Kiokee Cr.
Little Kiokee Cr.
Stevens
Lloyd Cr.
Horn Cr.
Cr.
Reed Cr.
Stevens Creek Dam
Augusta City Dam
Columbia Co.
Richmond Co.
Edgefield Co.
Aiken Co.
Fort Gordon
Rocky Cr.
Rocky
Butler
AUGUSTA
North Augusta
Spirit
Cr.
Clearwater
Little Horse
Langley
Cr.
Graniteville
Horse
Bath
Warrenville
Cr.
Aiken
L.
Spirit Cr.
Cr.
New Savannah Bluff L&D
Richmond Co.
Burke Co.
McBean
Cr.
Hollow Cr.
Beaverdam
SAVANNAH RIVER PLANT
ATOMIC ENERGY COMMISSION
Tims Br.
Upper
Three Runs
Cr.
Aiken Co.
Barnwell Co.
Timber Cr.
Fourmile
Savannah River
Pen Br.
Steel Br.
GA.
S.C.
Runs
Three
Beaverdam
Cr.
Barnwell Co.
Allendale Co.
Burke Co.
Screven Co.
Barnwell
Lower
Mill Cr.
U.S. 301 Br.
Allendale
N
SCALE IN MILES
5
0
5
10

SAVANNAH RIVER STUDY AREA
GEORGIA - SOUTH CAROLINA

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAVANNAH RIVER STUDY
JULY - AUGUST, 1970

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

presumably above sources of pollution, however the reach of the creek above KC-21 must receive contamination from the residential sections of Aiken, South Carolina through which it flows.

On the basis of the fauna, Kelly Creek, at all stations studied, is classified as "semi-healthy". On the basis of the physical characteristics of the substrate the organic load is greater at the downstream stations, however characteristics of the fauna show that minimal levels of dissolved oxygen (>1.0 ppm) were present at all stations for a minimum one to two week period preceding this study.

Little Horse Creek flows in a southerly direction through Clearwater, South Carolina to its junction with Horse Creek. At the two stations studied, one above and one below Clearwater, South Carolina, Little Horse Creek ranged from 20 to 25 feet in width with a slight current. The substrate above Clearwater was composed principally of cleanly washed sand, gravel and silt, contrasted with an abundance of active sludge deposits at the downstream station (LHC-33). At station LHC-31, above Clearwater, the sediments contained 1.9 per cent carbon while below Clearwater at LHC-33 the sediments contained 6.1 per cent carbon (Table 1). On the basis of the flora and fauna Little Horse Creek above Clearwater is a clean stream as contrasted with the downstream station which was "grossly polluted" by wastes originating in the vicinity of Clearwater, South Carolina (Appendix II).

## TABLE C-1

## LEVELS OF CARBON AND CHROMIUM FOUND IN SEDIMENTS FROM THE SAVANNAH RIVER AND TRIBUTARIES

| STATION | DATE SAMPLED | COD mg/kg | PERCENT CARBON | CHROMIUM mg/kg |
|---|---|---|---|---|
| S-73A | 8/4/70 | 44,400 | 1.7 | 7 |
| S-73E | " | 7,900 | 0.3 | <5 |
| S-75A | " | 80,600 | 3.0 | |
| S-75E | " | 17,700 | 0.7 | |
| S-53A | " | 6,160 | 0.2 | 12 |
| S-53E | " | 75,400 | 2.8 | 32 |
| S-76A | " | 155,600 | 5.8 | 670 |
| S-76E | " | 104,100 | 3.9 | 51 |
| S-78A | " | 69,100 | 2.6 | 38 |
| S-78E | " | 65,200 | 2.4 | 44 |
| KC-21 | 9/2/70 | 6,650 | 0.2 | |
| KC-22 | " | 108,900 | 4.1 | |
| KC-24 | " | 79,700 | 3.0 | |
| LHC-31 | " | 50,400 | 1.9 | 10 |
| LHC-33 | 9/3/70 | 163,200 | 6.1 | 163 |
| HC-35 | " | 71,900 | 2.7 | 990 |
| BC-5 | 9/1/70 | 11,800 | 0.4 | 7 |
| BC-6 | " | 103,200 | 3.9 | 81 |
| LSC-94 | " | 52,400 | 2.0 | |
| SC-10 | " | 4,250 | 0.2 | |
| SC-11 | 9/2/70 | 52,000 | 1.9 | |
| LTR-43 | 7/28/70 | 41,800 | 1.6 | |
| LTR-43 | " | 10,400 | 0.4 | |
| LTR-45 | " | 189,400 | 7.1 | |
| LTR-45 | " | 381,300 | 14.3 | |

Horse Creek was sampled at a station (HC-35) 1.6 miles above its junction with the Savannah River and below all sources of pollution. The water was dark gray in color and the transparency as measured by a secchi disc was only six inches. The substrate was coarse sand overlain with thick deposits of sludge along both shorelines. These sludge deposits contained 990 ppm of chromium (Table 1). Sewage fungus was abundant on rocks and tree limbs and only three genera of pollution tolerant algae were found. No living macroinvertebrate organisms were found. Horse Creek from this station (HC-35) to its junction with the Savannah River is "grossly polluted" by wastes from upstream sources.

Butler Creek drains an area along the southern outskirts of Augusta, Georgia and enters the Savannah River just below the Savannah Bluff Lock and Dam at mile 186.9. Butler Creek was sampled at mile 2.4 adjacent to the New Savannah Road Bridge (BC-5) and at mile 0.2 just above the park at Savannah Bluff Lock and Dam (BC-6). At the upstream station (BC-5) the creek was clear with a sandy bottom and had a flora and fauna indicating that the creek at this point was subject to moderate levels of organic pollution (Appendix II). The creek at this station is classified as "semi-healthy". At the downstream station (BC-6) the water was gray in color with persistent foam and the substrate was covered with active deposits of decomposing sludge containing 3.9 per cent carbon and 81 ppm of chromium. Growths of "sewage fungus" were abundant and the bottom was red with extensive beds of sludge worms. On the basis of its physical appearance and the flora and fauna this lower reach of Butler Creek is classified as "polluted" (Appendix II).

Spirit Creek drains an area just south of Butler Creek and joins the Savannah River at mile 182.8, approximately five miles below Savannah Bluff Lock and Dam (Fig. 1 ). The creek was sampled three miles from the mouth of Highway 56 bridge (Station SC-10), and approximately 50 yards upstream from its junction with the river (SC-11). An additional station was sampled on Little Spirit Creek approximately 0.7 miles from the junction with Spirit Creek (LSC-94).

Little Spirit Creek is a shallow, sandy-bottomed stream which was sufficiently clear on September 1, 1970 that the bottom was visible at all depths. On the basis of the diverse flora and fauna, which included sensitive forms of stoneflies and caddis flies (Appendix II ), this creek is classified as a "healthy" clean-water habitat.

At the upper station on Spirit Creek proper (SC-10) the substrate was clay overlain with sand and silt. On September 1, 1970 the creek was slightly turbid and the secchi disc could be observed at a maximum depth of 20 inches. The station supported a diverse and abundant flora and fauna (Appendix II), however sensitive forms were absent and the creek in this area is classified as "semi-healthy". Near the mouth of Spirit Creek at Station SC-11, the water was stained a dark tea color and the secchi disc could not be seen below 4.5 inches in depth. The creek channel was choked with fallen trees and logs, all of which were heavily coated with "sewage fungus". Only very tolerant forms of aquatic life were found at this station (Appendix II) and the creek is "grossly polluted".

Lower Three Runs Creek is an attractive stream draining a rural area of South Carolina on the southern edge of the Savannah River installation of the Atomic Energy Commission. Lower Three Runs Creek joins the Savannah River at mile 129.1 (Figure 3 ). Two stations were sampled on this creek, one above the effluent from the J. P. Stevens wool scouring plant and one below the entrance of the J. P. Stevens plant. The upper station (LTR-43) was adjacent to Highway 66 bridge at mile 6.5 (Figure 3 ). The creek at this station was approximately 30 feet wide, four feet in maximum depth, with very clear water having a faint tea color characteristic of coastal plain streams draining sandy, lowland swampy areas. This station supported a diverse community of macroinvertebrates including many forms intolerant of organic pollution (Appendix II) and the creek at this point is classified as "clean".

The lower station (LTR-45), at mile 4.0, was below the J. P. Stevens mill and adjacent to Highway 125 bridge. The water was a dark grey-brown color, and the bottom of the stream was covered with active sludge deposits. The average carbon content of two samples of the sediments was 10.7 per cent as contrasted with 1.0 per cent carbon at the upper station. The creek at this point supported a diverse community of invertebrates; however, none of the sensitive forms which were abundant at the upstream station were present. On the basis of the fauna present the creek at this station would be considered "polluted"; however, on the basis of physical appearance, the creek would fall in the category of "grossly polluted".

Savannah River Survey:

From river mile 202.7, adjacent to the North Augusta, South Carolina water intake downstream to river mile 128.1, near cut-off number 18B, a total of 20 stations was selected for study (Figure 1 ). The station at the North Augusta water intake was above all known waste sources in the Augusta area and the downstream stations were selected so that there was one "control" station immediately above each major potential waste source and from two to four stations at varying distances downstream from each source. It is important to recognize however that only the uppermost station (i.e. S-73 adjacent to the North Augusta, South Carolina water intake at river mile 202.7) is truly a control because all stations below the entrance of the first cut-off from the industrial canal at river mile 202.4 are subject to the individual and/or cumulative effects of all potential water sources which lie upstream of the station. The following discussion is based on the detailed description of the physical and biological characteristics of all stations studied as presented in Appendix III.

There was a distinct downstream change in the physical characteristics of the reach of the Savannah River studied and it can conveniently be divided into an "upper section" and a "lower section".

The "upper section", from the Augusta area downstream to Savannah Bluff Lock and Dam, was 150 to 200 yards in width with extensive shallow flats on both sides of the channel. These flats support dense beds of vascular plants dominated by waterweed (Elodea) and water milfoil (Myriophyllum). In the portion of the river adjacent to downtown Augusta, Georgia these beds were so dense as to make navigation difficult.

Water transparency, as measured by a secchi disc, in this upper section ranged from 41 inches to 64 inches except below Horse Creek where it was reduced, on the South Carolina side of the river, to 32 and 39 inches at Stations 76 and 79 respectively.

Except for the area immediately below Horse Creek, the substrate in the "upper section" was cleanly washed sand in the channel and sand overlain by silt on the flats. For a distance of at least 1000 yards below the mouth of Horse Creek the bottom of the left central portion of the river was coated with a slimy fibrous material high in organic matter and chromium. At Station 76, 100 yards below the mouth of Horse Creek, deposits ranged from 5.8 per cent carbon on the South Carolina side to 3.9 per cent carbon on the Georgia side of the river as compared with 0.7 to 1.7 per cent carbon at station 73 above all sources of pollution (Table 1). At the station below the mouth of Horse Creek the sludge deposits contained very high levels of chromium ranging from 51 ppm to 670 ppm, as compared with levels near the detection limit (5.0 ppm) at the upstream control station.

No information on the effects of high levels of chromium in sludge deposits are available, however, in water, chromium at levels much lower than those found in the Savannah River have been found to be toxic to forms of aquatic life ranging from fish to crustaceans and algae(6). Some crustaceans are killed at concentrations as low as 0.5 mg/l. Chromium at concentrations of 62.5 to 100 mg/l in water reduced the 5 day BOD by 50 per cent and concentrations of 5.0 mg/l has been found to cause a 50 per cent reduction in photosynthesis after 4 days. It is also reported that algae concentrate chromium by factors of 100 to 500 times the water concentration. The amount and effect of further biological magnification at higher levels in the food web is unknown but there is certainly a potential for rather drastic effects on the fish and other biological life in the reach of the Savannah River adjacent to Horse Creek.

The "upper section" receives wastes from downtown Augusta via Hawk's Gully and other outlets from the industrial canal, from the North Augusta, South Carolina sewer outfall, from Horse Creek and from the Columbia Nipro outfall ditch.

The "lower section", from Savannah Bluff Lock and Dam downstream to the Lower Three Runs area, was much narrower, averaging approximately 100 yards in width, with a swift current and steep, cut banks on one or both sides of the river. The banks on the inside of many bends were characterized by wide, shallow sand bars.

There were no extensive flats supporting beds of aquatic plants and the only extensive growths were adjacent to and between channel maintenance jetties where the current was reduced and silt deposits occurred. Except in the vicinity of jetties the bottom was cleanly washed sand with occasional outcrops of hard clay. The "lower section" receives wastes via Butler Creek, Spirit Creek and Lower Three Runs Creek.

Compared with the "upper section" transparency, as measured by a secchi disc, was somewhat reduced, ranging from 30 inches to 44 inches. For a distance of at least 100 yards below the mouth of Spirit Creek the highly colored water from Continental Can Corporation limited visibility of the secchi disc to 12 inches.

Sedgewick-Rafter counts of plankton grab samples from the Savannah River were quite low (Appendix II). There was a gradual downstream increase in plankton counts which ranged from lows of 50 cells per ml at the upper stations (73, 51 and 75) to a high of 297 cells per ml at station 47 which was just above the mouth of Lower Three Runs Creek in the "lower section" of the study area. Diatoms (particularly centrics) were the dominant component of the phytoplankton flora with increasing numbers of green and bluegreen algae appearing at downstream stations. This is the characteristic pattern of change in the algal community that is associated with water quality degradation.

The community of algae attached to glass slides (periphyton) was dominated by pennate diatoms at all stations studied (Appendix II). The upper control station (S-73) supported exclusively pennate diatoms, while downstream stations additionally supported varying numbers of green and bluegreen algae. The maximum total standing crop of periphyton and maximum standing crop of filamentous bluegreen algae were found at stations 52 and 75 respectively--both stations which were adjacent to downtown Augusta and one to two miles below all outlets from the industrial canal and the North Augusta, South Carolina sewer outfall. There was a drastic reduction in periphyton at the two stations below Spirit Creek, where the black liquor from Continental Can Corporation reduced light penetration.

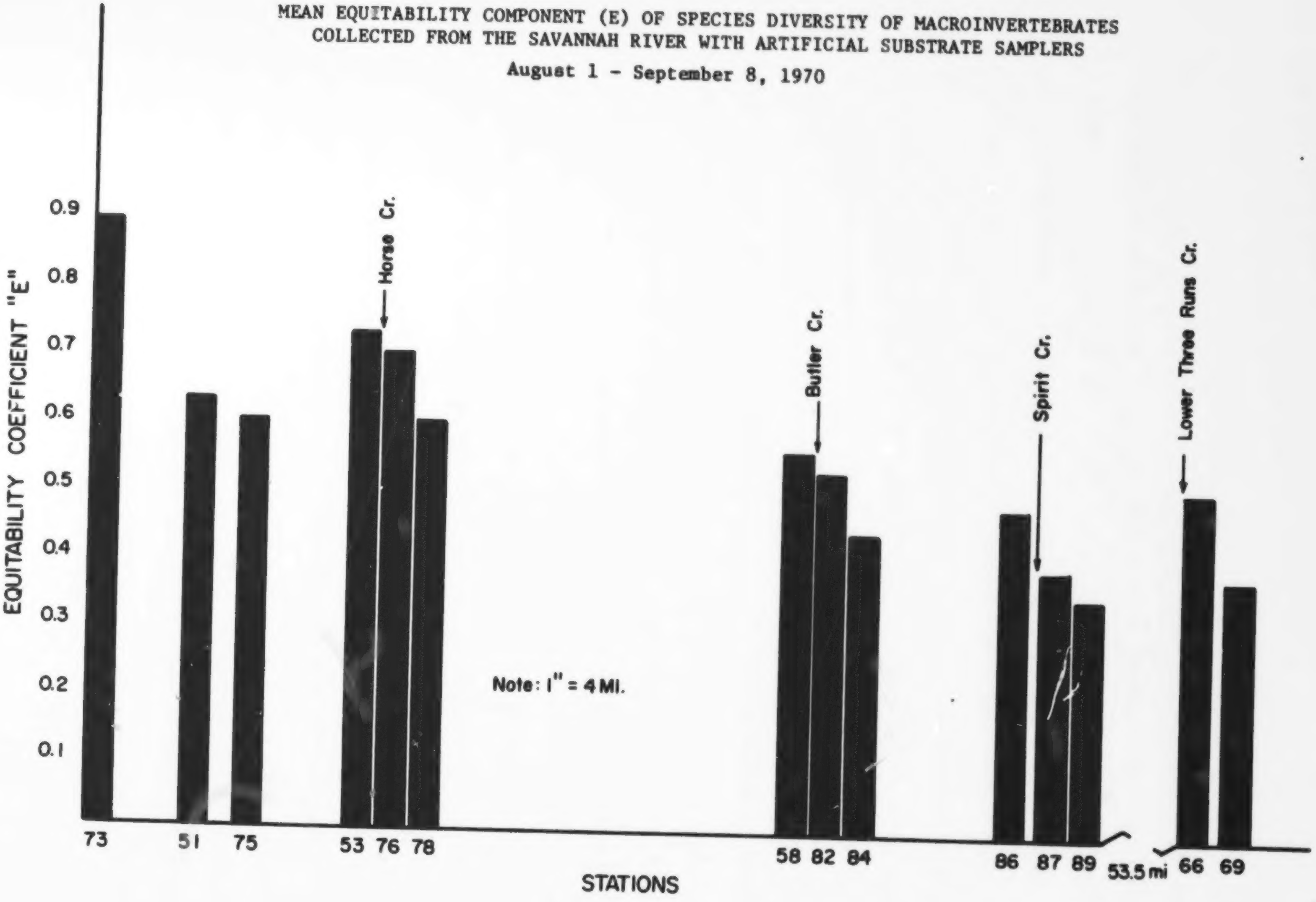
Using a variety of methods extensive collection of macroinvertebrates were made at most of the Savannah River stations. These collections revealed that the Savannah River at all stations sampled supported diverse communities of macroinvertebrates including forms intolerant of reduced oxygen levels associated with organic pollution (Appendix II). Differences between stations were related to natural differences in the physical characteristics of the habitat available to be sampled. At the station just below Horse Creek (S-76) which supported sludge deposits high in organic matter and chromium, orange peel dredge samples contained only one species of midge--*Chironomus attenuatus*. Over 75 per cent of the specimens of *Chironomus attenuatus* collected from these sludge deposits had morphological malformations such as deformed mandibles and labial plates. Numerous specimens of this species collected at station 53, above the mouth of Horse Creek, had no malformations.

The structure of the macroinvertebrate community which inhabited artificial substrate samplers, as measured by "E" the equitability component of species diversity, was characteristic of a healthy environment at station 73, adjacent to the North Augusta, South Carolina water supply intake (Fig. 5). There was a decreasing trend in "equitability" at downstream stations reaching a low at station 89 which is below the mouth of Spirit Creek and subject to the cumulative effects of all waste sources from the Augusta area. At both stations below Spirit Creek the equitability component was less than 0.4, a level characteristic of a semi-healthy bordering on polluted habitat. The increasing standing crops of macroinvertebrates inhabiting the samplers at the downstream stations is

FIGURE C-5

MEAN EQUITABILITY COMPONENT (E) OF SPECIES DIVERSITY OF MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER WITH ARTIFICIAL SUBSTRATE SAMPLERS

August 1 - September 8, 1970



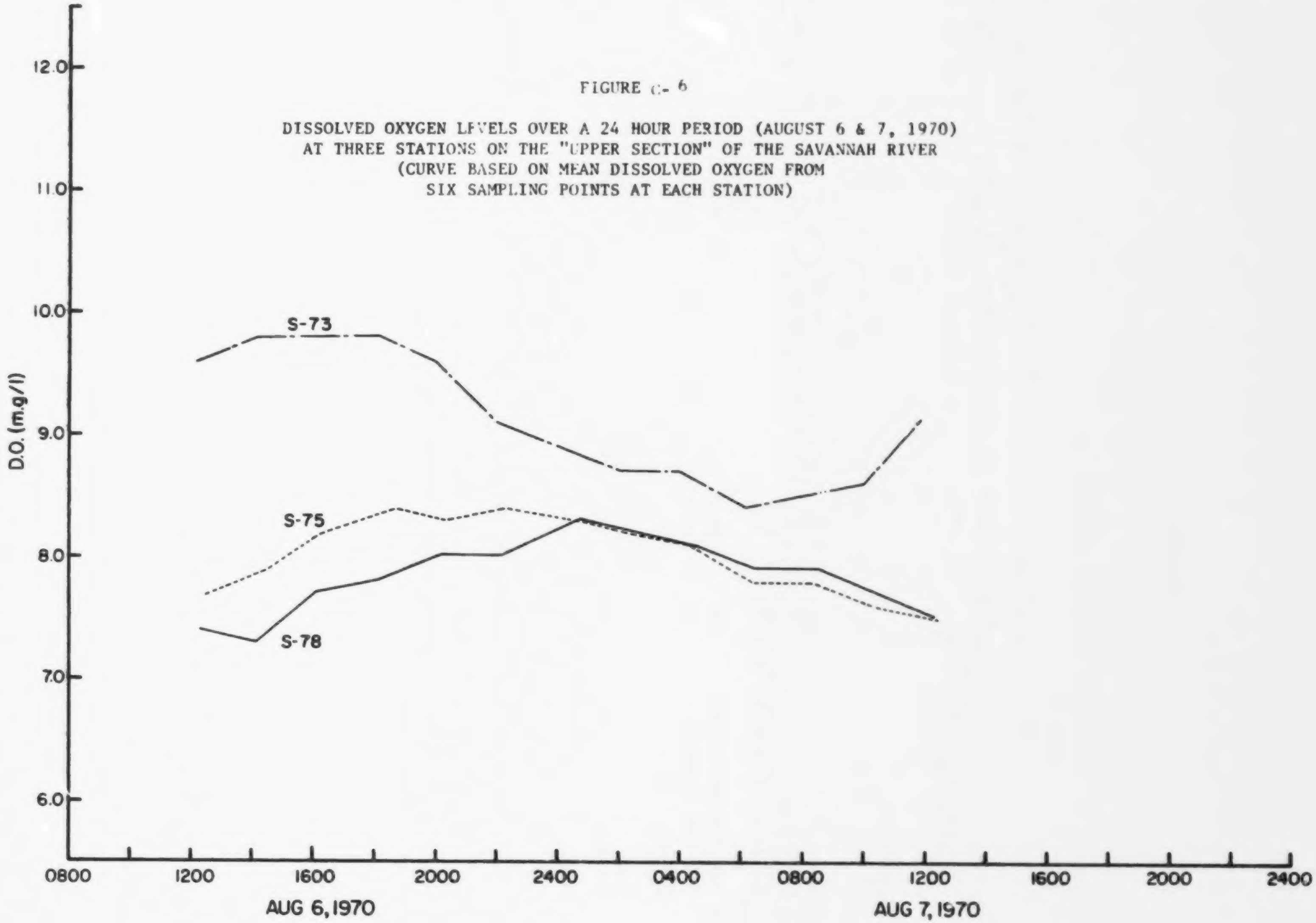
also evidence of an enriched habitat below the Augusta area (Appendix II).

Diurnal dissolved oxygen studies were conducted at six stations in the "upper section" of the study area which supported dense growths of vascular aquatic plants. These six stations were established in sets of two for obtaining a measure of production and respiration using the two station diurnal curve technique described by Odum(7). Flow time between each set of two stations averaged close to one hour. Curves drawn from the field data were uninterpretable from the standpoint of calculating production because of apparent night time increases in oxygen in a downstream direction and concomitant decreasing oxygen during daylight hours. An examination of individual station curves reveal that the upper station (S-73), which was above all sources of pollution, had a typical diurnal curve with a peak in late afternoon and the trough at night (Fig. 6). However at downstream stations (S-75 and S-78), which were affected by wastes from Hawk's Gully and Horse Creek, the peak occurred at night and the trough near mid-day. In addition the downstream curves were considerably depressed in magnitude.

During the 24 hour period over which these dissolved oxygen data were collected it is concluded that: (1) The oxygen demanding waste load imposed on this section of the Savannah River was not constant, and (2) The waste load imposed was of sufficient magnitude to obscure the effects of the photosynthetic and respiratory activity of the dense growths of vascular aquatic plants which were present.

FIGURE C- 6

DISSOLVED OXYGEN LEVELS OVER A 24 HOUR PERIOD (AUGUST 6 & 7, 1970)
AT THREE STATIONS ON THE "UPPER SECTION" OF THE SAVANNAH RIVER
(CURVE BASED ON MEAN DISSOLVED OXYGEN FROM
SIX SAMPLING POINTS AT EACH STATION)



## REFERENCES

(1) Effects of Pollution on Water Quality--Escambia River and Bay, Florida. January 1970. Southeast Water Laboratory, Federal Water Pollution Control Administration. 1970.

(2) Report on the Federal-State-Industry Cooperative Savannah River Water Quality Studies. 1956-1965. U. S. Dept. of Health Service. November, 1967.

(3) Augusta Water Quality Survey. Georgia Water Quality Control Board. September, 1970.

(4) Summary of Studies on the Savannah River, 1951-1970 for E. I. duPont de Nemours and Company. The Academy of Natural Sciences of Philadelphia. November, 1970.

(5) A Biological Survey of the Savannah River Sub-Basin. Southeast Region, Federal Water Pollution Control Administration. February-March, 1967.

(6) McKee, J. E. and Wolf. 1963. Water Quality Criteria. The Resources Agency of California, State Water Quality Control Board, Pub. number 3-A, 548 pp.

(7) Odum, H. T. 1956. Primary Production in Flowing Waters. Am. Soc. Limnology and Oceanography 1(2):102-117.

(8) Floyd, Monte and R. J. Ghelardi. 1964. A Table for Calculating the "Equitability" Component of Species Diversity. J. Animal Ecol. 33:217-225.

# APPENDIX C-I

## BIOLOGICAL METHODS

## I. PLANKTON

Replicate one liter grab samples were collected at a depth of one foot and sufficient formalin was added to obtain a concentration of four (4) per cent. Total plankton counts were made in a Sedgewick-Rafter cell at a magnification of 200x.

## II. PERIPHYTON

Periphyton samples were collected from the Savannah River by suspending five glass microscope slides in a plastic rack (Fig. 1) below a styrofoam float at a depth of approximately one foot. Collections from the tributary streams were made by attaching six replicate slides to bricks with "plasti-tak". All slides were retrieved at the end of a two week exposure period.

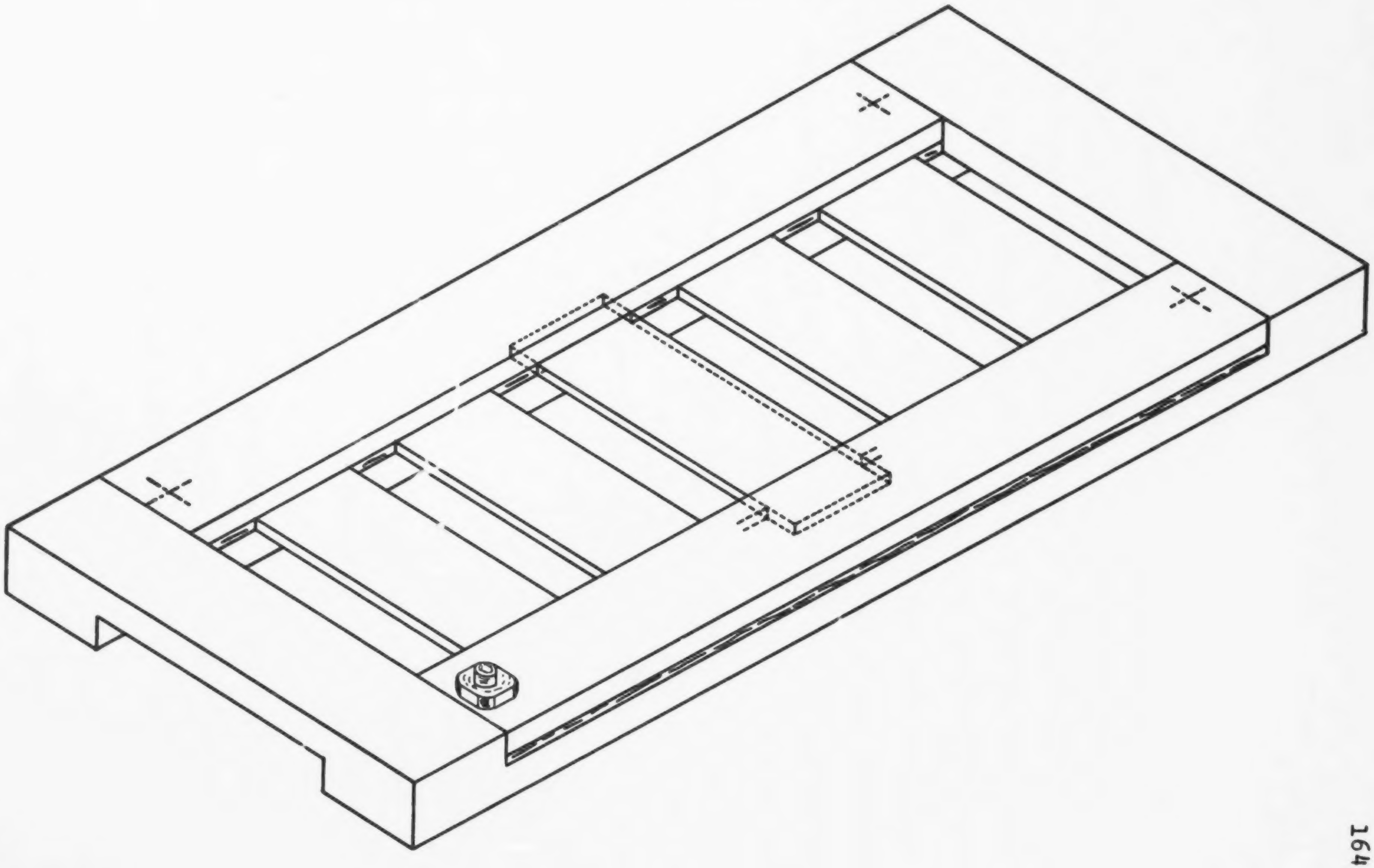
One slide from each set was preserved in 5 per cent formalin and the remaining slides were placed singly in jars containing a 90 per cent solution of acetone and frozen.

In the laboratory all material was scraped from the formalin preserved slides, dispersed in the original preservative by vigorous shaking, and additional four per cent formalin was added to obtain a total sample volume of 100 milliliters (ml). A Sedgwick-Rafter (S-R) count was made on a one ml aliquot of the sample and the cells per square millimeter ($mm^2$) of slide area was calculated as:

$$\text{Cells/mm}^2 = \frac{100 \times \text{S-R count (expressed in cells per ml)}}{\text{area of slide (mm}^2)}$$

FIGURE C-I-1

MICROSCOPE SLIDE RACK FOR COLLECTING PERIPHYTON



The acetone preserved slides were used for a determination of chlorophyll and biomass per square meter of slide surface. Chlorophyll was determined by reading the optical density of a centrifuged acetone extract at 665 and 750 mu using a Beckman Model B spectrophotometer. Corrections were made for physiologically inactive pigments by readings of the optical density of the extract before and after acidification with concentrated hydrochloric acid. Chlorophyll concentrations on individual slides were so low and variable that the data could not be interpreted and the results are not included as a part of this report.

Biomass was determined as ash-free weight by the difference between the dry weight and ashed weight of the centrifugate from the acetone preserved slides. The acetone extract was also evaporated to dryness and the ash-free weight of this material was added to the ash-free weight of the centrifugate.

## III. MACROINVERTEBRATES[1]

Qualitative collections of aquatic macroinvertebrates were made with dip nets, grabs (Petersen, Ekman and Orange Peel) and by visual examination and hand picking from vascular plants and debris. Quantitative collections were made with artificial substrate samplers.

The artificial substrate samplers used were wire baskets containing 1½" to 3" diameter crushed limestone as described by Mason, et. al.(1)

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[1] Defined as all invertebrates retained by a 30 mesh screen.

Two replicate samplers were submerged at a depth of three feet at each station sampled by this method. After six weeks exposure the samplers were retrieved, the organisms removed and preserved in labelled vials of 70 per cent ethyl alcohol.

Data from these samplers were used to calculate indices of diversity. The two components of species diversity are:

1. Richness of species
2. Equitability in the distribution of individuals among the species

Diversity was calculated using the Shannon-Wiener function:

$$H = -\sum_{r=1}^{s} P_r \log_2 P_r$$

where H = mean diversity per individual, P = proportion of individuals belonging to the $r^{th}$ species and s = number of species.

Equitability (E) was calculated by the method of Lloyd and Ghelardi(2)

"H", as calculated, is a combined measure of richness of species and equitability (evenness) of distribution of individuals among the species in the sample while "E" is a measure of equitability only. As calculated, "E" and "H" may range in value from zero to one, and from zero to 3.321928 log N respectively (N = total number of individuals). Maximum "H" may only be realized if each species is represented by one individual. If the distribution of individuals does approach equality of numbers then "E" may exceed one, however such an eventuality is rare.

Diversity serves as an excellent objective measure of environmental disturbance because any physical or chemical alteration, in the aquatic habitat, tends to favor certain species while reducing or eliminating those species which would normally be present under undisturbed conditions.

Richness of species may be considered as a measure of the structural diversity of the habitat and except under conditions of extreme degradation (septic conditions, toxic materials, lethal temperatures) is often relatively insensitive to subtle environmental changes. Equitability, or evenness of distribution of individuals among the species, is a sensitive measure of the stability of the physical and chemical characteristics of the environment.

By using a uniform substrate differences in diversity and equitability resulting from the physical structure of the habitat are kept to a minimum; hence reductions in these indices, particularly "E", may be attributed to differences in the chemical and/or physical characteristics of the aquatic environment.

## REFERENCES

(1) Mason, William T., Jr., Anderson, J. B., and Georgia E. Morrison. 1967. A limestone-filled artificial substrate sampler-float unit for collecting macroinvertebrates from large streams. Prog. Fish. Cult. 29(2):74.

(2) Lloyd, Monte and R. J. Ghelardi. 1964. A table for calculating the "equitability" component of species diversity. J. Animal Ecol. 33:217-225.

# APPENDIX II

## TABULAR SUMMARIES OF BIOLOGICAL DATA

| | |
|---|---|
| Table I. | Macroinvertebrates Collected from the Savannah River and Tributaries During August and September, 1970. |
| Table II. | Plankton Counts (cells/ml) from the Middle Savannah River (August 1-4, 1970). |
| Table III. | Attached Algae per square millimeter ($mm^2$) of Slide Surface from Savannah River Stations (slides exposed from August 1, 1970 through September 1, 1970). |
| Table IV. | Plankton Counts (cells/ml) from Lower Three Runs Creek and from Savannah River in Vicinity of Lower Three Runs Creek (July 28, 1970 - July 30, 1970). |
| Table V. | Qualitative Collections of Attached Algae from Stations on the Savannah River and Tributaries (August - September, 1970). |
| Table VI. | Standing Crop and Diversity of Macroinvertebrates Collected with Artificial Substrate Samplers from the Savannah River (August 1, 1970 - September 8, 1970). |

## TABLE C-I-I

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970[1,2]

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| DIPTERA | | | | | | | | | | | | | | | | | | | | |
| Chironomidae | | | | | | | | | | | | | | | | | | | | |
| Orthocladinae | | | | | | | | | | | | | | | | | | | | |
| Brillia par | - | P | - | - | - | - | P | P | - | - | - | - | - | - | - | P | P | P | - | - |
| Nanocladius alternantherae | - | P | P | P | P | P | P | P | P | P | P | P | P | P | - | C | P | C | C | P |
| Nanocladius sp. 1 of Roback | - | - | - | - | C | - | P | - | - | - | - | - | - | - | - | - | - | P | P | - |
| Nanocladius nr. sordens | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | P | P | - |
| Nanocladius sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cricotopus bicinctus | P | P | P | P | C | P | C | P | - | P | P | P | - | P | - | C | A | A | A | A |
| Cricotopus slossonae | P | P | P | - | P | - | C | - | - | P | - | P | P | P | - | P | P | P | C | C |
| Cricotopus ceris | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | P | P | - | - |
| Cricotopus trifasciatus | - | - | - | - | - | - | | P | - | - | - | - | - | P | - | - | - | - | - | P |
| Cricotopus sp. 2 of Roback | P | P | - | - | - | - | C | P | - | P | P | P | C | C | - | P | P | P | P | A |
| Trichocladius robacki | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Trichocladius nr. sp. 1 of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Trichocladius nr. sp. 2 of Roback | - | - | - | - | - | - | - | P | - | P | - | - | - | - | - | P | - | - | - | - |
| Psectrocladius sp. B of Beck | P | P | C | P | P | P | P | C | P | P | P | P | P | P | - | P | - | P | P | P |
| Orthocladius carlatus | - | - | - | P | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cardiocladius obscurus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Corynoneura (Thienemanniella) sp. 2 of Roback | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Thienemanniella) xena | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | P | - | - |

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1. Column Headings: A is the east sixth point on transect, E is the west sixth point.
2. Abundance Rating: P equals present (<10), C equals common (10-50), A equals abundant (>50).

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| DIPTERA | | | | | | | | | | | | | | | | | | |
| Chironomidae | | | | | | | | | | | | | | | | | | |
| Orthocladinae | | | | | | | | | | | | | | | | | | |
| *Brillia par* | - | - | - | - | P | - | - | - | - | P | - | - | - | - | - | - | P | - |
| *Nanocladius alternantherae* | C | C | P | P | P | - | - | P | P | A | C | P | - | P | P | - | P | P |
| *Nanocladius* sp. 1 of Roback | P | P | - | P | C | - | - | - | C | P | A | P | - | C | - | - | P | C |
| *Nanocladius* nr. *sordens* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Nanocladius* sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| *Cricotopus bicinctus* | A | A | C | A | A | - | - | C | A | C | A | P | - | C | C | - | P | C |
| *Cricotopus slossonae* | C | C | P | P | - | - | - | P | P | C | P | - | - | - | P | - | - | - |
| *Cricotopus ceris* | P | P | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cricotopus trifasciatus* | P | P | - | - | - | - | - | - | P | P | P | - | - | - | - | - | - | - |
| *Cricotopus* sp. 2 of Roback | P | C | - | P | P | - | - | - | P | P | C | - | - | - | - | - | P | - |
| *Trichocladius robacki* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Trichocladius* nr. sp. 1 of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Trichocladius* nr. sp. 2 of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Psectrocladius* sp. B of Beck | P | P | - | - | - | - | - | - | P | P | - | P | - | - | - | - | - | - |
| *Orthocladius carlatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cardiocladius obscurus* | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *C.* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| *Corynoneura* (*Thienemanniella*) sp. 2 of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *C.* (*Thienemanniella*) *xena* | - | P | - | - | - | - | - | - | P | - | A | - | - | - | P | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIPTERA | | | | | | | | | | | | | |
| Chironomidae | | | | | | | | | | | | | |
| Orthocladinae | | | | | | | | | | | | | |
| *Brillia par* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Nanocladius alternantherae* | - | - | - | - | P | - | P | - | - | - | - | - | - |
| *Nanocladius* sp. 1 of Roback | P | - | - | - | P | - | - | - | - | - | P | - | - |
| *Nanocladius* nr. *sordens* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Nanocladius* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cricotopus bicinctus* | - | - | P | P | C | - | P | - | P | - | - | - | - |
| *Cricotopus slossonae* | P | - | - | - | P | - | - | - | P | - | P | - | - |
| *Cricotopus ceris* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cricotopus trifasciatus* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cricotopus* sp. 2 of Roback | - | - | - | - | P | - | - | - | - | - | P | - | - |
| *Trichocladius robacki* | P | - | P | P | C | - | - | - | - | - | C | - | - |
| *Trichocladius* nr. sp. 1 of Roback | P | - | - | - | - | - | - | - | - | - | - | - | - |
| *Trichocladius* nr. sp. 2 of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Psectrocladius* sp. B of Beck | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Orthocladius carlatus* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cardiocladius obscurus* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *C*. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Corynoneura* (Thienemanniella) sp. 2 of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *C*. (*Thienemanniella*) *xena* | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| C. (Thienemanniella) sp. a of Roback | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| C. (Corynoneura) celeripes | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined genus nr. Corynoneura | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tanypodinae | | | | | | | | | | | | | | | | | | | | |
| Pentaneura (Pentaneura) inculta | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. carneosa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. (Nilotanypus) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | P | - |
| P. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ablabesmyia janta | P | P | C | C | P | C | P | P | P | P | P | P | - | - | P | P | P | - | - | - |
| A. hauberi | - | - | P | - | - | - | - | - | - | P | P | - | P | - | - | P | - | - | - | - |
| A. mallochi | P | C | P | C | P | C | P | C | P | C | P | C | P | P | - | P | P | P | C | P |
| A. ornata | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| A. auriensis | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| A. peleensis | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| Procladius culiciformis | - | - | P | - | - | - | P | - | - | - | - | - | C | - | - | - | - | - | - | - |
| P. nr. adumbratus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anatopynia (Psectrotanypus) dyari | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| A. (Psectrotanypus) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Clintoanypus thoracicus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. sp. | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Conchapelopia fasciata | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. sp. | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Labrundinia floridana | P | P | P | P | P | C | P | P | P | P | P | P | - | - | - | P | - | P | P | P |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| *C*. (*Thienemanniella*) sp. a of Roback | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *C*. (*Corynoneura*) *celeripes* | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Undetermined genus nr. *Corynoneura* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Tanypodinae | | | | | | | | | | | | | | | | | | |
| *Pentaneura* (*Pentaneura*) *inculta* | - | - | - | - | - | - | - | - | - | P | - | P | - | P | - | - | P | P |
| *P*. *carneosa* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *P*. (*Nilotanypus*) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *P*. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Ablabesmyia* *janta* | - | P | P | P | P | - | - | - | - | P | P | P | - | P | P | - | P | P |
| *A*. *hauberi* | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - |
| *A*. *mallochi* | P | C | P | P | - | - | - | P | P | C | P | P | - | - | - | - | - | - |
| *A*. *ornata* | - | - | - | - | - | - | - | - | - | - | P | P | - | - | - | - | - | - |
| *A*. *auriensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *A*. *peleensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Procladius* *culiciformis* | P | - | - | - | - | - | - | - | - | P | P | - | - | - | - | - | - | - |
| *P*. nr. *adumbratus* | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Anatopynia* (*Psectrotanypus*) *dyari* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *A*. (*Psectrotanypus*) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Clintoanypus* *thoracicus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *C*. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Conchapelopia* *fasciata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *C*. sp. | - | - | P | - | P | - | - | - | P | P | P | P | - | - | - | - | - | P |
| *Labrundinia* *floridana* | P | P | P | P | - | - | - | - | - | P | P | P | - | - | P | - | P | P |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C. (Thienemanniella) sp. a of Roback | P | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Corynoneura) celeripes | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined genus nr. Corynoneura | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Tanypodinae | | | | | | | | | | | | | |
| Pentaneura (Pentaneura) inculta | - | - | - | - | - | - | P | - | - | - | - | - | - |
| P. carneosa | - | - | - | - | - | - | - | - | - | - | - | - | P |
| P. (Nilotanypus) sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| P. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ablabesmyia janta | - | - | - | - | - | - | - | - | P | - | P | - | P |
| A. hauberi | - | - | - | - | - | - | - | - | P | - | - | - | - |
| A. mallochi | - | - | - | - | - | - | - | - | - | - | - | - | - |
| A. ornata | - | - | - | - | - | - | - | - | - | - | - | P | - |
| A. auriensis | P | - | - | - | - | - | - | - | - | - | - | - | - |
| A. peleensis | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Procladius culiciformis | - | - | - | C | - | - | C | - | - | - | - | P | - |
| P. nr. adumbratus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anatopynia (Psectrotanypus) dyari | - | - | - | - | - | - | - | - | - | - | - | - | C |
| A. (Psectrotanypus) sp. | - | - | - | - | - | - | - | P | - | - | - | - | - |
| Clintoanypus thoracicus | - | - | - | - | - | - | - | - | P | - | - | P | - |
| C. sp. | - | - | - | P | - | - | - | - | - | - | - | - | - |
| Conchapelopia fasciata | - | - | - | - | - | - | - | - | - | - | - | - | P |
| C. sp. | C | - | P | - | - | - | - | - | - | - | P | P | - |
| Labrundinia floridana | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tanypus stellatus | - | - | - | - | - | - | C | P | P | - | - | P | A |
| Undetermined sp | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Podonominae | | | | | | | | | | | | | |
| Undetermined genus nr. Podonomus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined genus nr. Boreochlis | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chironominae | | | | | | | | | | | | | |
| Chironomus (Chironomus) fulvipilus | - | - | - | - | - | - | - | P | P | P | - | - | C |
| C. (Chironomus) attenuatus | - | - | - | - | - | - | P | - | - | A | - | P | P |
| C. (Chironomus) crassicaudatus | - | - | - | - | - | - | - | P | - | - | - | - | - |
| C. (Chironomus) prasinus | - | - | - | - | - | - | - | - | - | - | - | - | P |
| C. (Dicrotendipes) modestus | - | - | - | - | - | - | - | - | P | - | - | P | - |
| C. (Dicrotendipes) incurvus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Dicrotendipes) neomodestus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) collator | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) galeator | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus pectinatellae | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) carinatus | - | - | - | - | - | - | - | - | P | - | - | - | - |
| C. (Cryptochironomus) fulvus | P | - | P | P | - | - | - | - | - | - | P | P | - |
| C. (Cryptochironomus) boydi | - | - | - | - | - | - | - | - | - | - | - | P | - |
| C. (Cryptochironomus) ponderosus | - | - | - | - | - | - | - | - | P | - | - | - | - |
| C. (Cryptochironomus) sp. 4 of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Endochironomus) nigricans | - | - | - | - | - | - | - | - | P | - | - | - | - |
| C. (Tribelos) jucundus | - | - | - | - | - | - | - | - | - | - | - | P | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Tanypus stellatus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Podonominae | | | | | | | | | | | | | | | | | | | | |
| Undetermined genus nr. Podonomus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined genus nr. Boreochlis | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chironominae | | | | | | | | | | | | | | | | | | | | |
| Chironomus (Chironomus) fulvipilus | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | P | - | - | - | P |
| C. (Chironomus) attenuatus | - | - | - | - | - | - | C | - | C | P | P | - | P | - | - | - | - | - | - | - |
| C. (Chironomus) crassicaudatus | - | - | - | - | - | - | P | - | P | - | - | - | - | - | P | - | - | - | - | - |
| C. (Chironomus) prasinus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Dicrotendipes) modestus | P | - | - | - | - | - | P | P | P | P | - | - | P | - | - | P | - | - | - | - |
| C. (Dicrotendipes) incurvus | - | - | P | - | - | - | - | C | - | C | - | P | P | P | P | P | - | - | - | P |
| C. (Dicrotendipes) neomodestus | P | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) collator | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) galeator | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) pectinatellae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) carinatus | - | - | - | P | P | - | P | P | P | P | C | - | - | C | P | C | C | P | C | P |
| C. (Cryptochironomus) fulvus | - | - | - | - | - | - | C | - | - | - | - | - | P | - | - | - | - | - | - | - |
| C. (Cryptochironomus) boydi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) ponderosus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) sp. 4 of Roback | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Endochironomus) nigricans | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Tribelos) jucundus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-85 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Tanypus stellatus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Podonominae | | | | | | | | | | | | | | | | | | |
| Undetermined genus nr. Podonomus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Undetermined genus nr. Boreochlis | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Chironominae | | | | | | | | | | | | | | | | | | |
| Chironomus (Chironomus) fulvipilus | P | P | - | P | - | - | - | - | - | P | - | P | - | - | - | - | - | - |
| C. (Chironomus) attenuatus | - | - | - | - | - | - | - | P | - | P | P | P | - | - | - | - | - | - |
| C. (Chironomus) crassicaudatus | - | - | - | - | - | - | - | - | P | C | - | - | - | - | - | - | - | - |
| C. (Chironomus) prasinus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| C. (Dicrotendipes) modestus | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Dicrotendipes) incurvus | P | P | - | - | P | - | - | - | - | P | - | - | - | - | - | - | - | - |
| C. (Dicrotendipes) neomodestus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) collator | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) galeator | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) pectinatellae | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | P | - |
| C. (Cryptochironomus) carinatus | C | A | C | P | P | - | - | P | P | A | P | C | - | - | - | - | P | P |
| C. (Cryptochironomus) fulvus | - | - | P | - | - | - | - | P | - | - | P | - | - | - | - | - | - | - |
| C. (Cryptochironomus) boydi | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) ponderosus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) sp. 4 of Roback | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| C. (Cryptochironomus) sp. | - | - | - | - | - | - | - | - | - | - | P | P | - | - | - | - | P | - |
| C. (Endochironomus) nigricans | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. (Tribelos) jucundus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

### MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| C. (Xenochironomus) xenolabis | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Demicryptochironomus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Microchironomus sp. | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| Pedionomus beckae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Glyptotendipes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cryptotendipes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Polypedilum (Polypedilum) illinoense | P | C | P | P | P | P | P | P | P | P | P | P | P | C | P | C | P | A | P | C |
| P. (Polypedilum) nr. illinoense | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. (Polypedilum) halterale | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| P. (Polypedilum) fallax | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. (Polypedilum) scalaenum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. (pentapedilum) nr. sordens | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stenochironomus hilaris | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| S. nr. hilaris | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| S. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - |
| Chironomini sp. c of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. I | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. II | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. III | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tanytarsus (Rheotanytarsus) exiguus | P | - | P | P | P | - | P | - | - | - | - | - | - | - | - | - | C | P | C | - |
| T. (Tanytarsus) varelus | - | P | P | P | - | P | C | C | P | A | - | C | - | P | P | C | P | P | P | - |
| T. (Tanytarsus) guerlus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. (Tanytarsus) glabrescens | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. (Tanytarsus) nr. boiemica | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. sp. A of Beck | - | - | - | - | - | - | - | P | - | P | - | P | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| C. (Xenochironomus) xenolabis | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | P | - |
| Demicryptochironomus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Microchironomus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pedionomus beckae | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Glyptotendipes sp. | - | - | P | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Cryptotendipes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Polypedilum (Polypedilum) illinoense | P | C | P | P | P | - | - | P | C | C | A | P | - | P | C | - | P | C |
| P. (Polypedilum) nr. illinoense | - | P | - | - | - | - | - | - | - | P | - | - | - | C | - | - | P | - |
| P. (Polypedilum) halterale | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| P. (Polypedilum) fallax | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. (Polypedilum) scalaenum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. (Pentapedilum) nr. sordens | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Stenochironomus hilaris | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| S. nr. hilaris | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| S. sp. | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Chironomini sp. c of Roback | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chironomini Undetermined sp. I | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. II | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. III | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tanytarsus (Rheotanytarsus) exiguus | P | P | C | C | C | - | - | - | C | A | A | C | - | A | C | - | A | A |
| T. (Tanytarsus) varelus | P | P | P | P | - | - | - | P | - | P | - | P | - | - | - | - | - | - |
| T. (Tanytarsus) guerlus | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| T. (Tanytarsus) glabrescens | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| T. (Tanytarsus) nr. boiemica | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. sp. A of Beck | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | P | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C. (Xenochironomus) xenolabis | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Demicryptochironomus sp. | P | - | - | - | - | - | - | - | P | - | - | - | - |
| Microchironomus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pedionomus beckae | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Glyptotendipes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cryptotendipes sp. | - | - | P | - | - | - | - | - | - | - | - | P | - |
| Polypedilum (Polypedilum) illinoense | P | - | P | P | C | - | - | P | C | - | P | - | A |
| P. (Polypedilum) nr. illinoense | P | - | - | - | - | - | - | - | P | - | C | - | - |
| P. (Polypedilum) halterale | P | - | P | - | - | - | - | - | P | - | - | - | - |
| P. (Polypedilum) fallax | P | - | P | P | - | - | P | - | - | - | - | - | C |
| P. (Polypedilum) scalaenum | - | - | P | - | - | - | - | - | - | - | - | - | - |
| P. (Pentapedilum) nr. sordens | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stenochironomus hilaris | - | - | - | - | - | - | - | - | - | - | - | - | - |
| S. nr. hilaris | - | - | - | - | - | - | - | - | - | - | - | - | - |
| S. sp. | C | - | - | - | - | - | - | - | - | - | P | - | - |
| Chironomini sp. c of Roback | P | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. I | P | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. II | P | - | - | - | - | - | - | - | - | - | - | - | - |
| C. Undetermined sp. III | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Tanytarsus (Rheotanytarsus) exiguus | C | - | - | - | C | - | P | - | P | - | C | - | - |
| T. (Tanytarsus) varelus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. (Tanytarsus) guerlus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. (Tanytarsus) glabrescens | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. (Tanytarsus) nr. boiemica | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. sp. A of Beck | P | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| *T*. sp. B of Beck | P | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *T*. (*Macrosandalum*) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Phaenopsectra flavipes* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Zavrelia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ceratopogonidae | | | | | | | | | | | | | | | | | | | | |
| *Palpomyia* sp. | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| *Probezzia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Culicoides* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Dasyhelea traverae* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | P | - | P | - | - | - | P | C | - | C | - | - | - | - | - | - | - | - | - | - |
| Simulidae | | | | | | | | | | | | | | | | | | | | |
| *Prosimulium* sp. | P | P | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Simulium* sp. | - | P | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Empididae | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | P | - |
| Culicidae | | | | | | | | | | | | | | | | | | | | |
| *Culex erraticus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Chaoborus punctipennis* | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| T. sp. B. of Beck | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| T. (Macrosandalum) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phaenopsectra flavipes | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Zavrelia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ceratopogonidae | | | | | | | | | | | | | | | | | | |
| Palpomyia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Probezzia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Culicoides sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dasyhelea traverae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | P | P | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Simulidae | | | | | | | | | | | | | | | | | | |
| Prosimulium sp. | - | - | - | - | P | - | - | - | - | - | A | C | - | A | C | - | C | A |
| Simulium sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Empididae | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | P | P | P | P | - | - | - | P | P | A | - | - | - | - | - | P | P |
| Culicidae | | | | | | | | | | | | | | | | | | |
| Culex erraticus | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Chaoborus punctipennis | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *T.* sp. B of Beck | P | - | P | - | - | - | - | - | P | - | - | P | - |
| *T.* (*Macrosandalum*) sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Phaenopsectra flavipes* | - | - | - | - | - | - | - | - | - | - | - | P | P |
| *Zavrelia* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Ceratopogonidae | | | | | | | | | | | | | |
| *Palpomyia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Probezzia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Culicoides* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Dasyhelea traverae* | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Undetermined sp. | P | - | P | - | - | - | - | - | P | - | - | - | A |
| Simulidae | | | | | | | | | | | | | |
| *Prosimulium* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Simulium* sp. | P | - | - | - | C | - | - | - | - | - | - | - | - |
| Empididae | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Culicidae | | | | | | | | | | | | | |
| *Culex erraticus* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Chaoborus punctipennis* | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Tipulidae | | | | | | | | | | | | | | | | | | | | |
| *Tipula* sp. | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Limnophora* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Limonia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| *Hexatoma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sciomyzidae | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - |
| Stratiomyidae | | | | | | | | | | | | | | | | | | | | |
| *Euparyphus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - |
| Tabanidae | | | | | | | | | | | | | | | | | | | | |
| *Crysops* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Psychodidae | | | | | | | | | | | | | | | | | | | | |
| *Pericoma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Ephydridae | | | | | | | | | | | | | | | | | | | | |
| *Brachydeutera* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EPHEMEROPTERA | | | | | | | | | | | | | | | | | | | | |
| Baetidae | | | | | | | | | | | | | | | | | | | | |
| *Baetis intercalaris* | P | - | P | P | A | P | C | - | - | - | P | P | - | - | P | - | C | C | C | - |

TABLE C-1-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Tipulidae | | | | | | | | | | | | | | | | | | |
| *Tipula* sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Limnophora* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Limonia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hexatoma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sciomyzidae | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stratiomyidae | | | | | | | | | | | | | | | | | | |
| *Euparyphus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tabanidae | | | | | | | | | | | | | | | | | | |
| *Crysops* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Psychodidae | | | | | | | | | | | | | | | | | | |
| *Pericoma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ephydridae | | | | | | | | | | | | | | | | | | |
| *Brachydeutera* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EPHEMEROPTERA | | | | | | | | | | | | | | | | | | |
| Baetidae | | | | | | | | | | | | | | | | | | |
| *Baetis intercalaris* | - | P | - | P | P | - | - | P | P | P | P | - | - | - | P | - | P | - |

## TABLE C-I-I(continued)

### MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tipulidae | | | | | | | | | | | | | |
| *Tipula* sp. | - | - | - | - | P | - | - | - | P | - | - | - | - |
| *Limnophora* sp. | - | P | - | - | - | - | - | - | - | - | - | - | - |
| *Limonia* sp. | - | - | - | - | - | - | - | P | - | - | - | - | - |
| *Hexatoma* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Sciomyzidae | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stratiomyidae | | | | | | | | | | | | | |
| *Euparyphus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tabanidae | | | | | | | | | | | | | |
| *Crysops* sp. | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Psychodidae | | | | | | | | | | | | | |
| *Pericoma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ephydridae | | | | | | | | | | | | | |
| *Brachydeutera* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | P | - | - | - | - | - |
| EPHEMEROPTERA | | | | | | | | | | | | | |
| Baetidae | | | | | | | | | | | | | |
| *Baetis intercalaris* | P | - | - | - | - | - | - | - | C | - | - | - | - |

TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| B. spinosus | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Pseudocloeon alachua | - | - | P | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Cloeon sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Callibaetis floridanus | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - |
| Ameletus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Isonychia pictipes | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| I. sp. B of Berner | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Caenidae | | | | | | | | | | | | | | | | | | | | |
| Caenis hilaris | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tricorythodes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Ephemeridae | | | | | | | | | | | | | | | | | | | | |
| Hexagenia mu[illegible] marilandica | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Heptageniidae | | | | | | | | | | | | | | | | | | | | |
| Heptagenia flavescens | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stenonema smithae | C | P | C | - | A | P | C | P | - | P | - | P | - | P | - | - | P | P | P | - |
| S. exiguum | - | - | P | P | C | - | P | P | - | - | - | P | - | - | - | - | - | - | - | - |
| TRICHOPTERA | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| *B. spinosus* | - | - | - | - | - | - | - | - | - | - | P | P | - | - | - | - | - | - |
| *Pseudocloeon alachua* | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| *Cloeon* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Callibaetis floridanus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Ameletus* sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| *Isonychia pictipes* | - | - | - | - | - | - | - | - | - | - | A | C | - | A | - | - | A | A |
| *I.* sp. B of Berner | - | - | - | - | - | - | - | - | - | - | A | - | - | - | - | - | C | - |
| Undetermined sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Caenidae | | | | | | | | | | | | | | | | | | |
| *Caenis hilaris* | - | - | - | - | - | - | - | - | - | - | P | P | - | P | P | - | P | C |
| *Tricorythodes* sp. | - | - | - | - | - | - | - | - | - | - | P | P | - | C | P | - | C | - |
| Ephemeridae | | | | | | | | | | | | | | | | | | |
| *Hexagenia munda marilandica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Heptageniidae | | | | | | | | | | | | | | | | | | |
| *Heptagenia flavescens* | - | - | - | - | - | - | - | - | - | - | C | - | - | P | - | - | - | - |
| *Stenonema smithae* | - | P | - | - | - | - | - | - | P | - | P | P | - | C | - | - | C | P |
| *S. exiguum* | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | P | - |
| TRICHOPTERA | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I(continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B. spinosus | - | - | - | - | - | - | C | - | - | - | - | - | - |
| Pseudocloeon alachua | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cloeon sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Callibaetis floridanus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ameletus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Isonychia pictipes | - | - | - | - | - | - | - | - | - | - | - | - | - |
| I. sp. B of Berner | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Caenidae | | | | | | | | | | | | | |
| Caenis hilaris | - | - | - | - | - | - | - | - | P | - | - | - | - |
| Tricorythodes sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Ephemeridae | | | | | | | | | | | | | |
| Hexagenia munda marilandica | - | - | - | - | - | - | - | - | - | - | P | P | - |
| Heptageniidae | | | | | | | | | | | | | |
| Heptagenia flavescens | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stenonema smithae | C | - | - | C | C | - | - | - | C | - | P | P | - |
| S. exiguum | - | - | - | - | - | - | - | - | P | - | - | - | - |
| TRICHOPTERA | | | | | | | | | | | | | |
| Undetermined sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Hydroptilidae | | | | | | | | | | | | | | | | | | | | |
| Agraylea multipunctata | P | C | C | - | P | P | C | P | - | P | - | - | - | - | - | - | P | - | C | - |
| Oxyethira sp. | P | C | P | P | - | P | P | A | C | - | P | - | - | P | - | - | - | - | P | - |
| Agraylea sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Limnephilidae | | | | | | | | | | | | | | | | | | | | |
| Pseudostenophylax sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydropsychidae | | | | | | | | | | | | | | | | | | | | |
| Hydropsyche sp. | - | - | - | - | A | P | C | - | - | P | - | P | - | - | - | - | C | P | C | - |
| Cheumatopsyche sp. | P | P | - | - | A | - | C | - | - | P | - | - | - | - | - | - | - | P | - | - |
| Macronemum sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| M. carolina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| M. zebratum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Philopotamidae | | | | | | | | | | | | | | | | | | | | |
| Chimarra socia | P | - | - | - | A | - | C | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Brachycentridae | | | | | | | | | | | | | | | | | | | | |
| Brachycentrus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Leptoceridae | | | | | | | | | | | | | | | | | | | | |
| Oecetis sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Leptocella candida | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Triaenodes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Athripsodes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLC C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

|  | S-84 |  | S-86 |  | S-87 |  | S-88 |  | S-89 |  | S-47 |  | S-66 |  | S-68 |  | S-69 |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Hydroptilidae |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Agraylea multipunctata | C | - | P | - | - | - | - | - | P | - | P | P | - | P | P | - | - | P |
| Oxyethira sp. | - | P | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Agraylea sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Limnephilidae |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Pseudostenophylax sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydropsychidae |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Hydropsyche sp. | - | P | P | P | A | - | - | P | A | A | A | P | - | A | P | - | P | C |
| Cheumatopsyche sp. | - | - | - | - | - | - | - | P | C | - | A | A | - | A | - | - | A | A |
| Macronemum sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | P |
| M. carolina | - | P | - | - | - | - | - | - | - | P | C | A | - | A | - | - | P | A |
| M. zebratum | - | - | - | - | - | - | - | - | - | - | P | P | - | C | - | - | - | C |
| Philopotamidae |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Chimarra socia | - | - | - | - | P | - | - | - | - | P | A | A | - | A | - | - | C | A |
| Brachycentridae |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Brachycentrus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Leptoceridae |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Oecetis sp. | - | - | - | - | - | - | - | P | - | P | C | C | - | C | - | - | P | C |
| Leptocella candida | P | - | - | - | - | - | - | - | - | - | P | - | - | P | - | - | P | P |
| Triaenodes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | C | - | - | - |
| Athripsodes sp. | - | - | - | - | - | - | - | - | - | - | - | P | - | - | P | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hydroptilidae | | | | | | | | | | | | | |
| Agraylea multipunctata | - | - | - | - | - | - | - | - | P | - | - | - | - |
| Oxyethira sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Agraylea sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Limnephilidae | | | | | | | | | | | | | |
| Pseudostenophylax sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydropsychidae | | | | | | | | | | | | | |
| Hydropsyche sp. | P | - | - | - | - | - | - | - | P | - | P | - | - |
| Cheumatopsyche sp. | P | - | P | P | P | P | - | - | C | - | C | - | - |
| Macronemum sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| M. carolina | C | - | - | - | - | - | - | - | - | - | A | - | - |
| M. zebratum | P | - | - | - | - | - | - | - | - | - | C | - | - |
| Philopotamidae | | | | | | | | | | | | | |
| Chimarra socia | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Brachycentridae | | | | | | | | | | | | | |
| Brachycentrus sp. | - | - | - | - | - | - | - | - | - | - | P | - | - |
| Leptoceridae | | | | | | | | | | | | | |
| Oecetis sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Leptocella candida | - | - | - | - | - | - | - | - | - | - | P | - | - |
| Triaenodes sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Athripsodes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Psychomyiidae | | | | | | | | | | | | | | | | | | | | |
| Neureclipsis crepuscularis | P | - | P | - | A | P | C | - | - | P | - | - | - | - | - | - | P | - | P | - |
| PLECOPTERA | | | | | | | | | | | | | | | | | | | | |
| Pternonarcidae | | | | | | | | | | | | | | | | | | | | |
| Pteronarcys sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Peltoperlidae | | | | | | | | | | | | | | | | | | | | |
| Peltoperla sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Perlidae | | | | | | | | | | | | | | | | | | | | |
| Acroneuria sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phasganophora capitata | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Perlodidae | | | | | | | | | | | | | | | | | | | | |
| Isoperla sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ODONATA | | | | | | | | | | | | | | | | | | | | |
| Gomphidae | | | | | | | | | | | | | | | | | | | | |
| Progomphus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Gomphus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Aeschinidae | | | | | | | | | | | | | | | | | | | | |
| Nasiaeschna sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Boyeria sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Psychomyiidae | | | | | | | | | | | | | | | | | | |
| *Neureclipsis crepuscularis* | P | - | P | - | - | - | - | - | - | - | A | A | - | A | - | - | A | A |
| PLECOPTERA | | | | | | | | | | | | | | | | | | |
| Pternonarcidae | | | | | | | | | | | | | | | | | | |
| *Pteronarcys* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Peltoperlidae | | | | | | | | | | | | | | | | | | |
| *Peltoperla* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Perlidae | | | | | | | | | | | | | | | | | | |
| *Acroneuria* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Phasganophora capitata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Perlodidae | | | | | | | | | | | | | | | | | | |
| *Isoperla* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ODONATA | | | | | | | | | | | | | | | | | | |
| Gomphidae | | | | | | | | | | | | | | | | | | |
| *Progomphus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Gomphus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Aeschnidae | | | | | | | | | | | | | | | | | | |
| *Nasiaeschna* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Boyeria* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Psychomyiidae | | | | | | | | | | | | | |
| *Neureclipsis crepuscularis* | P | - | - | - | - | - | - | - | - | - | - | P | - |
| PLECOPTERA | | | | | | | | | | | | | |
| Pternonarcidae | | | | | | | | | | | | | |
| *Pteronarcys* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Peltoperlidae | | | | | | | | | | | | | |
| *Peltoperla* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Perlidae | | | | | | | | | | | | | |
| *Acroneuria* sp. | - | - | - | - | - | - | - | - | - | - | P | - | - |
| *Phasganophora capitata* | P | - | - | - | - | - | - | - | - | - | P | - | - |
| Perlodidae | | | | | | | | | | | | | |
| *Isoperla* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| ODONATA | | | | | | | | | | | | | |
| Gomphidae | | | | | | | | | | | | | |
| *Progomphus* sp. | P | - | - | P | - | - | P | - | - | - | - | - | - |
| *Gomphus* sp. | - | - | P | - | - | - | - | - | - | - | - | P | - |
| Aeschnidae | | | | | | | | | | | | | |
| *Nasiaeschna* sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| *Boyeria* sp. | P | - | P | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Libellulidae | | | | | | | | | | | | | | | | | | | | |
| *Neurocordulia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Macromia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Erythemis* sp. | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - |
| *Pachydiplax* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - |
| *Orthemis* sp. | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - |
| *Epicordulia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Sympetrum* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Coenagrionidae | | | | | | | | | | | | | | | | | | | | |
| *Coenagrion* sp. | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - |
| *Enallagma* sp. | P | - | P | P | - | - | - | C | - | - | - | - | - | - | - | - | - | - | P | - |
| *Ischnura* sp. | - | P | - | P | - | - | - | P | C | P | - | - | - | P | - | - | - | P | - | - |
| *Argia* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | P | P | - | - | - | - | - | - | P | - | - | - | - | P | - | - | - | - | P | - |
| Calopterygidae | | | | | | | | | | | | | | | | | | | | |
| *Calopteryx* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hetaerina* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| COLEOPTERA | | | | | | | | | | | | | | | | | | | | |
| Gyrinidae | | | | | | | | | | | | | | | | | | | | |
| *Gyrinus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - |
| *Gyretes* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Dineutus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - |

## TABLE C-I-I(continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Libellulidae | | | | | | | | | | | | | | | | | | |
| Neurocordulia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Macromia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Erythemis sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pachydiplax sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Orthemis sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Epicordulia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sympetrum sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Coenagrionidae | | | | | | | | | | | | | | | | | | |
| Coenagrion sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Enallagma sp. | - | - | - | - | - | - | - | P | P | - | P | - | - | - | - | - | - | - |
| Ischnura sp. | P | - | - | P | - | - | - | - | P | P | P | - | - | - | - | - | - | - |
| Argia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | P | - | P | P | - | - | - | - | P | P | - | - | - | - | - | - | - | - |
| Calopterygidae | | | | | | | | | | | | | | | | | | |
| Calopteryx sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hetaerina sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| COLEOPTERA | | | | | | | | | | | | | | | | | | |
| Gyrinidae | | | | | | | | | | | | | | | | | | |
| Gyrinus sp. | - | - | P | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - |
| Gyretes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | P | - | - |
| Dineutus sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Libellulidae | | | | | | | | | | | | | |
| Neurocordulia sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Macromia sp. | P | - | - | - | - | - | P | - | P | - | - | P | - |
| Erythemis sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pachydiplax sp. | - | - | - | - | - | - | - | - | - | - | - | - | C |
| Orthemis sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Epicordulia sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Sympetrum sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Coenagrionidae | | | | | | | | | | | | | |
| Coenagrion sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Enallagma sp. | P | - | - | - | - | - | - | - | - | - | - | - | P |
| Ischnura sp. | P | - | - | - | - | - | - | - | P | - | - | - | C |
| Argia sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Undetermined sp. | P | - | - | - | P | - | - | - | P | - | - | - | - |
| Calopterygidae | | | | | | | | | | | | | |
| Calopteryx sp. | P | - | - | P | P | - | P | - | - | - | - | - | - |
| Hetaerina sp. | P | - | - | - | P | - | - | - | - | - | - | - | - |
| COLEOPTERA | | | | | | | | | | | | | |
| Gyrinidae | | | | | | | | | | | | | |
| Gyrinus sp. | P | - | - | - | - | - | - | - | - | - | P | - | - |
| Gyretes sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dineutus sp. | - | - | - | - | - | - | P | - | - | P | - | P | - |

## TABLE C-I-I (continued)

### MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Haliplidae | | | | | | | | | | | | | | | | | | | | |
| Peltodytes sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dytiscidae | | | | | | | | | | | | | | | | | | | | |
| Hydroporus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Matus sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - |
| Copelatus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Celina sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Derovatellus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydaticus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Noteridae | | | | | | | | | | | | | | | | | | | | |
| Suphisellus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydrophilidae | | | | | | | | | | | | | | | | | | | | |
| Hydrochus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tropisternus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Berosus sp. | P | - | - | P | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydrobius sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Psephenidae | | | | | | | | | | | | | | | | | | | | |
| Ectopria sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES .OLLECTED FKOM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Haliplidae | | | | | | | | | | | | | | | | | | |
| *Peltodytes* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Dytiscidae | | | | | | | | | | | | | | | | | | |
| *Hydroporus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| *Matus* sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| *Copelatus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Celina* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Derovatellus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hydaticus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Noteridae | | | | | | | | | | | | | | | | | | |
| *Suphisellus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Hydrophilidae | | | | | | | | | | | | | | | | | | |
| *Hydrochus* sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Tropisternus* sp. | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| *Berosus* sp. | - | P | - | - | - | - | - | - | - | P | - | - | - | - | P | - | - | - |
| *Hydrobius* sp. | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| Psephenidae | | | | | | | | | | | | | | | | | | |
| *Ectopria* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Haliplidae | | | | | | | | | | | | | |
| Peltodytes sp. | - | - | - | P | - | - | - | - | P | - | - | - | - |
| Dytiscidae | | | | | | | | | | | | | |
| Hydroporus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Matus sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Copelatus sp. | - | - | - | - | - | - | - | P | - | - | - | - | - |
| Celina sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Derovatellus sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Hydaticus sp. | - | - | - | - | - | - | - | P | - | - | - | - | - |
| Noteridae | | | | | | | | | | | | | |
| Suphisellus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Hydrophilidae | | | | | | | | | | | | | |
| Hydrochus sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Tropisternus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Berosus sp. | - | - | - | - | - | - | - | - | P | - | - | P | P |
| Hydrobius sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Psephenidae | | | | | | | | | | | | | |
| Ectopria sp. | P | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I(continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Elmidae | | | | | | | | | | | | | | | | | | | | |
| *Stenelmis* sp. | - | - | - | P | P | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Ancyronyx* *variegatus* | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - |
| *A*. sp. | - | - | - | - | - | - | - | - | - | - | - | - | C | - | - | - | - | - | - | - |
| *Dubiraphia* *vittata* | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *D*. sp. | - | - | A | - | - | - | - | P | - | P | - | - | P | - | - | - | - | - | P | - |
| *Macronychus* *glabratus* | - | - | P | - | - | - | - | - | - | - | - | - | - | P | - | - | - | P | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chrysomelidae | | | | | | | | | | | | | | | | | | | | |
| *Donacia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MEGALOPTERA | | | | | | | | | | | | | | | | | | | | |
| Sialidae | | | | | | | | | | | | | | | | | | | | |
| *Sialis* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Corydalidae | | | | | | | | | | | | | | | | | | | | |
| *Corydalus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HEMIPTERA | | | | | | | | | | | | | | | | | | | | |
| Corixidae | | | | | | | | | | | | | | | | | | | | |
| *Sigara* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | P | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Mesoveliidae | | | | | | | | | | | | | | | | | | | | |
| *Mesovelia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Elmidae | | | | | | | | | | | | | | | | | | |
| Stenelmis sp. | - | P | - | - | - | - | - | - | P | P | P | P | - | P | - | - | P | P |
| Ancyronyx variegatus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| A. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dubiraphia vittata | - | - | - | - | - | - | - | P | - | - | - | - | - | - | P | - | - | - |
| D. sp. | P | - | - | - | - | - | - | - | - | C | - | - | - | - | - | - | - | - |
| Macronychus glabratus | - | - | - | - | - | - | - | - | - | - | P | - | - | - | P | - | - | - |
| Undetermined sp. | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chrysomelidae | | | | | | | | | | | | | | | | | | |
| Donacia sp. | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - |
| MEGALOPTERA | | | | | | | | | | | | | | | | | | |
| Sialidae | | | | | | | | | | | | | | | | | | |
| Sialis sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Corydalidae | | | | | | | | | | | | | | | | | | |
| Corydalus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HEMIPTERA | | | | | | | | | | | | | | | | | | |
| Corixidae | | | | | | | | | | | | | | | | | | |
| Sigara sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | P | - |
| Mesoveliidae | | | | | | | | | | | | | | | | | | |
| Mesovelia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I(continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elmidae | | | | | | | | | | | | | |
| *Stenelmis* sp. | C | - | - | - | - | - | - | - | C | - | C | - | - |
| *Ancyronyx variegatus* | - | - | - | - | - | - | - | - | - | - | P | - | - |
| *A*. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Dubiraphia vittata* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *D*. sp. | - | - | P | - | - | - | - | - | P | - | P | - | - |
| *Macronychus glabratus* | P | - | - | - | - | - | - | - | P | - | P | - | P |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chrysomelidae | | | | | | | | | | | | | |
| *Donacia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MEGALOPTERA | | | | | | | | | | | | | |
| Sialidae | | | | | | | | | | | | | |
| *Sialis* sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Corydalidae | | | | | | | | | | | | | |
| *Corydalus* sp. | P | - | - | - | P | - | - | P | - | - | P | - | - |
| HEMIPTERA | | | | | | | | | | | | | |
| Corixidae | | | | | | | | | | | | | |
| *Sigara* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | P | P | - | - | - |
| Mesoveliidae | | | | | | | | | | | | | |
| *Mesovelia* sp. | - | - | - | - | - | - | - | - | P | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Gerridae | | | | | | | | | | | | | | | | | | | | |
| *Gerris* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Rheumatobates* sp. | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - |
| *Trepobates* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Veliidae | | | | | | | | | | | | | | | | | | | | |
| *Rhagovelia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LEPIDOPTERA | | | | | | | | | | | | | | | | | | | | |
| Pyralididae | | | | | | | | | | | | | | | | | | | | |
| *Nymphula* sp. | - | P | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| OLIGOCHAETA | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | P | - | - | - | - | - | - | - | - | - | P | - | P | - | - | P | - | - |
| Naididae | | | | | | | | | | | | | | | | | | | | |
| *Nais* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Stylaria* sp. | - | C | A | C | - | A | A | C | - | P | - | - | - | - | - | - | P | C | P | - |
| *Pristina breviseta* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - |
| *P.* sp. | P | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | P | - | - | - | - | - | - | - | - | - | - | - | - | - | C | - | - | - | - | - |
| Tubificidae | | | | | | | | | | | | | | | | | | | | |
| *Aulodrilus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | A | - | C | - | P | - | A | - | - | P | - | - | A | - | C | - | - | - | - | P |
| Lumbriculidae | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| Gerridae | | | | | | | | | | | | | | | | | | |
| Gerris sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Rheumatobates sp. | P | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - |
| Trepobates sp. | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Veliidae | | | | | | | | | | | | | | | | | | |
| Rhagovelia sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LEPIDOPTERA | | | | | | | | | | | | | | | | | | |
| Pyralididae | | | | | | | | | | | | | | | | | | |
| Nymphula sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| OLIGOCHAETA | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | | | | | | | | | | | | | | | | | | |
| Naididae | | | | | | | | | | | | | | | | | | |
| Nais sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stylaria sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pristina breviseta | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | P | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tubificidae | | | | | | | | | | | | | | | | | | |
| Aulodrilus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Undetermined sp. | P | - | - | C | - | - | - | C | - | C | - | - | - | - | P | - | - | - |
| Lumbriculidae | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gerridae | | | | | | | | | | | | | |
| Gerris sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Rheumatobates sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Trepobates sp. | - | - | - | - | - | - | - | - | P | - | - | - | - |
| Veliidae | | | | | | | | | | | | | |
| Rhagovelia sp. | - | - | P | - | - | - | - | - | - | - | - | - | - |
| LEPIDOPTERA | | | | | | | | | | | | | |
| Pyralididae | | | | | | | | | | | | | |
| Nymphula sp. | - | - | - | - | - | - | - | - | P | - | - | - | - |
| OLIGOCHAETA | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Naididae | | | | | | | | | | | | | |
| Nais sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stylaria sp. | - | - | - | - | - | - | | - | - | - | - | - | - |
| Pristina breviseta | - | - | - | - | - | - | - | - | - | - | - | - | - |
| P. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | P | - | - | A | P | - | - | - | - |
| Tubificidae | | | | | | | | | | | | | |
| Aulodrilus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | P | - | P | - | - | - | C | - | P | - | - | - | P |
| Lumbriculidae | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | P | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| **CRUSTACEA** | | | | | | | | | | | | | | | | | | | | |
| Talitridae | | | | | | | | | | | | | | | | | | | | |
| *Hyalella azteca* | C | C | C | C | C | P | C | A | A | C | P | A | P | A | A | A | P | A | C | A |
| Gammaridae | | | | | | | | | | | | | | | | | | | | |
| *Gammarus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Astacidae | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | P | - | - | - | - | - | - | - | - | - | P | - | - | P | - | - | - |
| Palaemoniidae | | | | | | | | | | | | | | | | | | | | |
| *Palaemonetes paludosus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Asellidae | | | | | | | | | | | | | | | | | | | | |
| *Asellus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **PELECYPODA** | | | | | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | | | |
| *Villosa* sp. | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sphaeriidae | | | | | | | | | | | | | | | | | | | | |
| *Sphaerium* sp. | C | - | P | P | - | - | - | P | P | P | - | - | - | P | C | - | - | - | - | - |
| *Eupera* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Pisidium* sp. | C | - | C | - | - | - | C | - | - | C | - | - | - | - | C | - | - | - | P | - |
| *Musculium* sp. | - | - | - | P | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| CRUSTACEA | | | | | | | | | | | | | | | | | | |
| Talitridae | | | | | | | | | | | | | | | | | | |
| Hyalella azteca | A | A | C | P | - | - | - | C | C | A | C | - | - | - | C | - | - | P |
| Gammaridae | | | | | | | | | | | | | | | | | | |
| Gammarus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Astacidae | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Palaemoniidae | | | | | | | | | | | | | | | | | | |
| Palaemonetes paludosus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Asellidae | | | | | | | | | | | | | | | | | | |
| Asellus sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PELECYPODA | | | | | | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | | | | | | |
| Villosa sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sphaeriidae | | | | | | | | | | | | | | | | | | |
| Sphaerium sp. | - | - | - | - | - | - | - | C | - | - | P | - | - | - | - | - | - | - |
| Eupera sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | P | - | - | - | - |
| Pisidium sp. | - | - | P | C | - | - | - | C | - | - | - | - | - | - | - | - | - | - |
| Musculium sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I(continued).

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRUSTACEA | | | | | | | | | | | | | |
| Talitridae | | | | | | | | | | | | | |
| *Hyalella azteca* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Gammaridae | | | | | | | | | | | | | |
| *Gammarus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Astacidae | | | | | | | | | | | | | |
| Undetermined sp. | - | - | P | C | P | - | - | - | P | - | - | P | P |
| Palaemoniidae | | | | | | | | | | | | | |
| *Palaemonetes paludosus* | P | - | - | - | - | - | - | - | - | - | - | - | - |
| Asellidae | | | | | | | | | | | | | |
| *Asellus* sp. | - | - | - | - | P | - | - | - | - | - | - | - | - |
| PELECYPODA | | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | | |
| *Villosa* sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Sphaeriidae | | | | | | | | | | | | | |
| *Sphaerium* sp. | P | - | - | P | C | - | P | - | P | - | - | P | - |
| *Eupera* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Pisidium* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Musculium* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| GASTROPODA | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Viviparidae | | | | | | | | | | | | | | | | | | | | |
| *Campeloma* sp. | - | - | C | - | P | - | P | - | - | C | - | - | - | - | C | - | - | - | - | - |
| Bulimidae | | | | | | | | | | | | | | | | | | | | |
| *Clappia* sp. | C | C | C | C | - | - | C | C | C | P | - | P | P | C | C | P | - | - | P | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ancylidae | | | | | | | | | | | | | | | | | | | | |
| *Ferrissia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | P | - |
| Pleuroceridae | | | | | | | | | | | | | | | | | | | | |
| *Goniobasis* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lymnaeidae | | | | | | | | | | | | | | | | | | | | |
| *Pseudosuccinea* sp. | P | P | - | - | - | - | - | C | P | - | - | - | - | P | - | - | - | - | - | - |
| Planorbidae | | | | | | | | | | | | | | | | | | | | |
| *Gyraulus* sp. | P | - | P | C | - | - | - | A | A | P | - | - | - | A | P | - | P | P | P | - |
| *Helisoma* sp. | P | - | P | P | - | - | P | C | P | P | - | - | - | P | P | - | - | - | - | - |
| Physidae | | | | | | | | | | | | | | | | | | | | |
| *Physa* sp. | P | P | C | C | P | P | C | A | A | P | P | P | P | A | C | C | P | C | C | P |
| NEMERTEA | | | | | | | | | | | | | | | | | | | | |
| *Prostoma rubrum* | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| GASTROPODA | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Viviparidae | | | | | | | | | | | | | | | | | | |
| *Campeloma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Bulimidae | | | | | | | | | | | | | | | | | | |
| *Clappia* sp. | P | - | - | - | - | - | - | P | - | P | P | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Ancylidae | | | | | | | | | | | | | | | | | | |
| *Ferrissia* sp. | - | - | P | - | - | - | - | P | - | P | P | - | - | - | - | - | - | - |
| Pleuroceridae | | | | | | | | | | | | | | | | | | |
| *Goniobasis* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lymnaeidae | | | | | | | | | | | | | | | | | | |
| *Pseudosuccinea* sp. | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Planorbidae | | | | | | | | | | | | | | | | | | |
| *Gyraulus* sp. | - | - | - | P | - | - | - | P | - | P | P | - | - | - | P | - | - | C |
| *Helisoma* sp. | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Physidae | | | | | | | | | | | | | | | | | | |
| *Physa* sp. | A | A | C | A | - | - | - | C | C | P | A | P | - | - | C | - | P | P |
| NEMERTEA | | | | | | | | | | | | | | | | | | |
| *Prostoma rubrum* | - | C | - | - | - | - | - | - | - | P | - | - | - | - | - | - | P | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LBC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GASTROPODA | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Viviparidae | | | | | | | | | | | | | |
| *Campeloma* sp. | P | - | - | - | - | - | - | - | - | - | - | C | - |
| Bulimidae | | | | | | | | | | | | | |
| *Clappia* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ancylidae | | | | | | | | | | | | | |
| *Ferrissia* sp. | - | - | - | - | - | - | P | - | - | - | - | P | P |
| Pleuroceridae | | | | | | | | | | | | | |
| *Goniobasis* sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Lymnaeidae | | | | | | | | | | | | | |
| *Pseudosuccinea* sp. | - | - | - | P | - | - | - | - | - | - | - | P | - |
| Planorbidae | | | | | | | | | | | | | |
| *Gyraulus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Helisoma* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Physidae | | | | | | | | | | | | | |
| *Physa* sp. | - | - | - | - | - | - | P | - | - | P | - | - | C |
| NEMERTEA | | | | | | | | | | | | | |
| *Prostoma rubrum* | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| NEMATODA | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - | - | - | - | P |
| HIRUDINEA | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | C | P | P | P | - | - | P | - | - | P | - | P | - | - | C | P | - | P | - | - |
| TURBELLARIA | | | | | | | | | | | | | | | | | | | | |
| Planariidae | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | C | P | P | P | P | P | - | - | - | - | - | - | - | - | P | - | - | - | P |
| HYDRACARINA | | | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | P | - | - | - | - | - | - | P | - | - | - | P | - | - | - | - | - | P | - |
| BRYOZOA | | | | | | | | | | | | | | | | | | | | |
| Urnatella gracilis | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PISCES | | | | | | | | | | | | | | | | | | | | |
| Ictaluridae | | | | | | | | | | | | | | | | | | | | |
| Ictalurus platycephalus | - | - | P | P | - | - | P | - | - | P | - | - | - | - | - | - | - | - | P | - |
| Noturus leptacanthus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Centrarchidae | | | | | | | | | | | | | | | | | | | | |
| Lepomis microlophus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| L. sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Micropterus salmoides | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| NEMATODA | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HIRUDINEA | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | P | - | - | - | - | - | P | P | P | P | P | - | - | - | - | - | - |
| TURBELLARIA | | | | | | | | | | | | | | | | | | |
| Planariidae | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | - | P | - | P | - | - | - | - | - | - | P | C | - | - | - | - | P | - |
| HYDRACARINA | | | | | | | | | | | | | | | | | | |
| Undetermined sp. | P | - | - | - | - | - | - | - | - | C | C | - | - | - | - | - | - | - |
| BRYOZOA | | | | | | | | | | | | | | | | | | |
| *Urnatella gracilis* | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |
| PISCES | | | | | | | | | | | | | | | | | | |
| Ictaluridae | | | | | | | | | | | | | | | | | | |
| *Ictalurus platycephalus* | - | P | - | - | - | - | - | - | P | P | P | - | - | - | P | - | - | - |
| *Noturus leptacanthus* | - | - | - | - | - | - | - | P | - | - | P | - | - | - | - | - | - | - |
| Centrarchidae | | | | | | | | | | | | | | | | | | |
| *Lepomis microlophus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *L.* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Micropterus salmoides* | - | - | - | - | - | - | - | - | - | - | P | - | - | - | - | - | - | - |

TABLE C-I-I (continued)

MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES
DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEMATODA | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HIRUDINEA | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | P | P | - | - | - | - | - | - | - | - |
| TURBELLARIA | | | | | | | | | | | | | |
| Planariidae | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | P | - | - | - | - | - | - |
| HYDRACARINA | | | | | | | | | | | | | |
| Undetermined sp. | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BRYOZOA | | | | | | | | | | | | | |
| *Urnatella gracilis* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PISCES | | | | | | | | | | | | | |
| Ictaluridae | | | | | | | | | | | | | |
| *Ictalurus platycephalus* | - | - | - | - | - | - | - | - | - | - | - | P | - |
| *Noturus leptacanthus* | - | - | - | - | - | - | - | - | - | - | P | - | - |
| Centrarchidae | | | | | | | | | | | | | |
| *Lepomis microlophus* | - | - | - | - | - | - | - | - | P | - | - | - | - |
| *L.* sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| *Micropterus salmoides* | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-73 | | S-51 | | S-75 | | S-53 | | S-76 | | S-78 | | S-79 | | S-81 | | S-58 | | S-82 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| *Elassoma zonatum* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Enneacanthus chaetodon* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Aphredoderidae | | | | | | | | | | | | | | | | | | | | |
| *Aphredoderus sayanus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Percidae | | | | | | | | | | | | | | | | | | | | |
| *Etheostoma nigrum* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anguillidae | | | | | | | | | | | | | | | | | | | | |
| *Anguilla rostrata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Poeceliidae | | | | | | | | | | | | | | | | | | | | |
| *Gambusia affinis* | - | - | - | P | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| AMPHIBIA | | | | | | | | | | | | | | | | | | | | |
| Plethodontidae | | | | | | | | | | | | | | | | | | | | |
| *Desmognathus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-I (continued)

## MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | S-84 | | S-86 | | S-87 | | S-88 | | S-89 | | S-47 | | S-66 | | S-68 | | S-69 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E | A | E |
| *Elassoma zonatum* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| *Enneacanthus chaetodon* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Sphredoderidae | | | | | | | | | | | | | | | | | | |
| *Aphredoderus sayanus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Percidae | | | | | | | | | | | | | | | | | | |
| *Etheostoma nigrum* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anguillidae | | | | | | | | | | | | | | | | | | |
| *Anguilla rostrata* | - | P | - | - | - | - | - | - | - | - | P | - | - | - | - | - | P | P |
| Poeceliidae | | | | | | | | | | | | | | | | | | |
| *Gambusia affinis* | - | - | - | - | - | - | - | - | - | C | - | - | - | - | P | - | - | - |
| AMPHIBIA | | | | | | | | | | | | | | | | | | |
| Plethodontidae | | | | | | | | | | | | | | | | | | |
| *Desmognathus* sp. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

### TABLE C-I-I (continued)

### MACROINVERTEBRATES COLLECTED FROM THE SAVANNAH RIVER AND TRIBUTARIES DURING AUGUST AND SEPTEMBER, 1970

| | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | HC-35 | BC-5 | BC-6 | SC-10 | SC-11 | LSC-94 | LTR-43 | LTR-45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Elassoma zonatum* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Enneacanthus chaetodon* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Aphredoderidae | | | | | | | | | | | | | |
| *Aphredoderus sayanus* | - | - | - | - | - | - | - | - | - | - | - | P | - |
| Percidae | | | | | | | | | | | | | |
| *Etheostoma nigrum* | - | - | - | - | - | - | - | - | - | - | P | P | - |
| Anguillidae | | | | | | | | | | | | | |
| *Anguilla rostrata* | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Poeceliidae | | | | | | | | | | | | | |
| *Gambusia affinis* | - | - | - | - | - | - | P | - | - | - | P | P | - |
| AMPHIBIA | | | | | | | | | | | | | |
| Plethodontidae | | | | | | | | | | | | | |
| *Desmognathus* sp. | - | - | P | - | - | - | - | - | - | - | - | - | - |

## TABLE C-I-II

PLANKTON COUNTS (cells/mℓ) FROM THE MIDDLE SAVANNAH RIVER
(August 1-4, 1970)

| | 73 | 73 | 51 | 51 | 75 | 75 | 53 | 53 | 76 | 76 |
|---|---|---|---|---|---|---|---|---|---|---|
| Coccoid Blue Greens | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| Filamentous Blue Greens | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coccoid Greens | 33 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 |
| Filamentous Greens | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| Green Flagellates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | C | 0 |
| Diatoms | | | | | | | | | | |
| Centrics | 0 | 66 | 33 | 33 | 33 | 0 | 33 | 33 | 33 | 33 |
| Pennates | 0 | 0 | 33 | 0 | 33 | 0 | 33 | 0 | 66 | 0 |
| MEAN TOTAL ALGAE PER STATION | 33 | 66 | 66 | 33 | 99 | 0 | 99 | 33 | 99 | 66 |
| | 50 | | 50 | | 50 | | 66 | | 82 | |

## TABLE C-I-II(continued)

## PLANKTON COUNTS (cells/mℓ) FROM THE MIDDLE SAVANNAH RIVER (August 1-4, 1970)

| | 78 | 78 | 81 | 81 | 58 | 58 | 82 | 83 | 83 | 84 |
|---|---|---|---|---|---|---|---|---|---|---|
| Coccoid Blue Greens | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Filamentous Blue Greens | 0 | 0 | 0 | 0 | 0 | 33 | 33 | 0 | 0 | 0 |
| Coccoid Greens | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 |
| Filamentous Greens | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| Green Flagellates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diatoms | | | | | | | | | | |
| Centrics | 99 | 66 | 264 | 132 | 33 | 66 | 66 | 132 | 66 | 66 |
| Pennates | 33 | 66 | 33 | 33 | 66 | 33 | 99 | 33 | 99 | 33 |
| MEAN TOTAL ALGAE PER STATION | 132 | 132 | 297 | 165 | 99 | 132 | 231 | 165 | 165 | 66 |
| | 132 | | 231 | | 116 | | 231 | 165 | | 132 |

TABLE C-I-II (continued)

PLANKTON COUNTS (cells/mℓ) FROM THE MIDDLE SAVANNAH RIVER
(August 1-4, 1970)

| | 85 | 85 | 86 | 86 | 87 | 87 | 88 | 89 | 89 | 90 | 91 | 91 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coccoid Blue Greens | 0 | 0 | 66 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 |
| Filamentous Blue Greens | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 |
| Coccoid Greens | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 33 | 33 | 33 | 0 |
| Filamentous Greens | 0 | 0 | 0 | 33 | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green Flagellates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diatoms | | | | | | | | | | | | |
| Centrics | 33 | 99 | 99 | 99 | 132 | 132 | 165 | 165 | 33 | 66 | 132 | 99 |
| Pennates | 33 | 33 | 33 | 33 | 66 | 132 | 66 | 0 | 33 | 66 | 0 | 0 |
| | 66 | 132 | 198 | 231 | 264 | 264 | 231 | 165 | 99 | 165 | 231 | 99 |
| MEAN TOTAL ALGAE PER STATION | 99 | | 214 | | 264 | | 231 | 132 | | 165 | 165 | |

### TABLE C-I-III

### ATTACHED ALGAE PER SQUARE MILLIMETER ($mm^2$) OF SLIDE SURFACE FROM SAVANNAH RIVER STATIONS
(August 1, 1970 - September 1, 1970)

| | 73 | 74 | 75 | 52 | 53 | 79 | 81 | 58 | 82 | 85 | 87 | 89 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coccoid Blue Greens | 0 | 6 | 48 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| Filamentous Blue Greens | 0 | 42 | 485 | 26 | 0 | 12 | 11 | 29 | 5 | 2 | 72 | 36 |
| Coccoid Green | 0 | 0 | 20 | 2 | 65 | 71 | 13 | 0 | 2 | 3 | 0 | 4 |
| Filamentous Green | 0 | 0 | 5 | 29 | 33 | 149 | 13 | 6 | 18 | 0 | 25 | 55 |
| Green Flagellates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Pigmented Flagellates | 2 | 2 | 3 | 11 | 7 | 3 | 15 | 6 | 57 | 13 | 8 | 12 |
| Diatoms | | | | | | | | | | | | |
| Centrics | 0 | 9 | 2 | 2 | 1 | 5 | 37 | 3 | 4 | 14 | 4 | 6 |
| Pennates | 565 | 401 | 737 | 2304 | 915 | 770 | 698 | 1556 | 616 | 837 | 84 | 139 |
| TOTAL ALGAE[1] | 565 | 458 | 1296 | 2364 | 1014 | 1008 | 791 | 1594 | 645 | 855 | 186 | 239 |

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[1] Does not include pigmented flagellates.

## TABLE C-I-IV

### PLANKTON COUNTS (cells/mℓ) FROM LOWER THREE RUNS CREEK AND FROM SAVANNAH RIVER IN VICINITY OF LOWER THREE RUNS CREEK (July 28, 1970 - July 30, 1970)

| | 43 | 43 | 43 | 45 | 45 | 45 | 47 | 47 | 47 | 68 | 68 | 68 | 71 | 71 | 71 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coccoid Blue Greens | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 66 | 33 | 0 | 33 | 0 | 33 | 0 |
| Filamentous Blue Greens | 0 | 0 | 0 | 33 | 66 | 231 | 0 | 33 | 0 | 0 | 0 | 0 | 33 | 0 | 0 |
| Coccoid Green | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 33 | 0 | 66 | 33 | 33 | 0 |
| Filamentous Green | 0 | 0 | 0 | 0 | 0 | 33 | 66 | 0 | 66 | 33 | 0 | 66 | 0 | 0 | 0 |
| Green Flagellates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 33 | 0 |
| Other Pigmented Flagellates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diatoms | | | | | | | | | | | | | | | |
| Centrics | 66 | 0 | 33 | 66 | 66 | 66 | 99 | 132 | 132 | 99 | 99 | 66 | 132 | 165 | 99 |
| Pennates | 33 | 33 | 66 | 99 | 66 | 66 | 33 | 99 | 66 | 33 | 66 | 33 | 33 | 33 | 99 |
| TOTAL ALGAE | 99 | 33 | 99 | 198 | 198 | 396 | 198 | 330 | 363 | 231 | 165 | 264 | 231 | 297 | 198 |
| | | 77 | | | 264 | | | 297 | | | 220 | | | 242 | |

## TABLE C-I-V

### QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

| | STATIONS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILAMENTOUS BLUE GREENS | BC-6 | HC-35 | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | SC-10 | LSC-94 | S-47A | S-71A | S-72A | S-76A |
| Oscillatoria (agardhii) | P | C | - | C | - | A | - | - | P | - | P | - | C |
| O. (ornata) | C | - | - | - | - | - | - | - | - | - | - | - | - |
| O. (pseudogeminata) | - | A | A | - | - | A | P | P | P | P | - | - | C |
| O. (chlorina) | - | - | - | - | - | P | - | P | - | - | - | - | - |
| O. (amphibia) | - | - | - | - | - | - | P | - | - | - | - | - | - |
| O. (splendida) | - | - | - | - | - | - | - | - | C | - | P | - | - |
| O. sp. | - | - | - | - | P | P | - | - | P | - | - | - | - |
| Lyngbya (versicolor) | - | - | P | - | - | - | - | - | - | - | - | - | - |
| L. (digueti) | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Anabaena constricta | - | - | P | - | - | P | P | P | P | P | C | - | - |
| Anabaena sp. | - | - | - | - | - | - | - | - | P | - | - | - | - |
| Spirulina (nordstedtii) | - | - | - | - | - | - | - | - | - | - | - | - | P |

## TABLE C-I-V (continued)

## QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

| | STATIONS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COCCOID GREEN ALGAE | BC-6 | HC-35 | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | SC-10 | LSC-94 | S-47A | S-71A | S-72A | S-76A |
| Cosmarium (portianum) | - | - | P | - | - | P | - | - | P | - | - | - | - |
| C. botrytis | - | - | P | P | - | P | - | P | P | - | - | - | - |
| Scenedesmus bijuga | - | - | P | P | - | - | - | P | - | - | - | - | P |
| S. quadricauda | - | - | - | P | - | - | - | P | - | - | - | - | P |
| S. dimorphus | - | - | - | P | - | - | - | - | - | - | - | - | P |
| S. sp. | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Closterium sp. | - | - | P | - | A | C | P | P | P | - | - | - | - |
| C. moniliferum | - | - | - | - | - | - | - | - | - | - | C | - | - |
| Pediastrum tetras | - | - | P | - | - | - | - | - | - | - | - | - | P |
| Ankistrodesmus falcatus | - | - | P | - | - | - | - | - | - | - | - | - | P |
| Staurastrum (punctulatum) | - | - | - | P | - | - | - | - | - | - | - | - | - |
| Coelastrum microporum | - | - | - | P | - | - | - | - | - | - | - | - | P |
| Batrachospermum vagum | - | - | A | - | - | - | - | - | C | - | - | - | - |
| Chlorella sp. | - | - | - | - | - | - | - | - | - | - | - | - | P |
| Penium (desmid) | - | - | - | - | - | - | P | P | - | - | - | - | - |

TABLE C-I-V (continued)

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

| | STATIONS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILAMENTOUS GREEN ALGAE | BC-6 | HC-35 | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | SC-10 | LSC-94 | S-47A | S-71A | S-72A | S-76A |
| *Cladophora* *glomerata* | A | - | - | - | - | A | - | - | C | - | - | - | - |
| *Spirogyra* *majuscula* | - | - | P | - | - | - | A | - | A | - | - | A | - |
| *S*. *fluviatilis* | - | - | - | - | - | - | - | - | A | - | - | - | - |
| *S*. sp. | - | - | - | - | - | - | - | - | - | P | C | - | - |
| *Mougeotia* sp. | - | - | P | - | - | - | - | - | P | - | - | A | - |
| *Oedogonium* *grande* | - | - | - | - | - | - | A | - | - | - | - | - | - |
| *O*. *surecium* | - | - | - | - | - | - | - | - | P | - | - | - | - |
| *Vauchevia* sp. | - | - | - | - | - | - | - | - | - | A | - | - | - |
| *Zygnema* sp. | - | - | - | - | - | - | - | - | - | - | - | P | - |
| *Ulothrix* (*tenerrima*) | - | - | - | - | - | - | - | - | - | - | - | - | P |

## TABLE C-I-V (continued)

## QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

| | STATIONS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREEN FLAGELLATES | BC-6 | HC-35 | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | SC-10 | LSC-94 | S-47A | S-71A | S-72A | S-76A |
| Trachelomonas sp. | - | P | P | - | - | - | P | - | - | - | - | - | - |
| T. crebea | - | - | - | P | - | - | - | - | - | - | - | - | - |
| OTHER PIGMENTED FLAGELLATES | | | | | | | | | | | | | |
| Dinoflagellate shells | - | P | - | - | - | - | - | - | - | - | - | - | - |
| Shells present | - | - | - | P | - | - | - | - | - | - | - | - | - |

TABLE C-I-V (continued)

QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

| | STATIONS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PENNATES | BC-6 | HC-35 | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | SC-10 | LSC-94 | S-47A | S-71A | S-72A | S-76A |
| Navicula | A | P | C | - | A | A | P | A | C | P | C | P | P |
| Synedra (pulchella) | - | - | P | - | - | - | - | - | - | - | - | - | - |
| S. sp. | - | - | - | - | - | - | P | - | P | P | C | P | P |
| Tabellaria fenestrata | - | - | P | - | - | - | - | - | P | - | P | - | - |
| T. floculosa | - | - | P | P | - | - | P | - | - | - | P | - | - |
| T. sp. | - | - | - | - | - | P | - | - | P | P | - | - | - |
| Nitzschia acicularis | - | - | P | - | - | - | - | - | P | - | - | - | - |
| N. linearis | - | - | - | - | - | - | - | - | P | - | - | - | - |
| N. sp. | - | - | - | - | - | - | - | - | - | P | P | - | - |
| Fragillaria sp. | - | - | - | - | - | P | - | - | - | - | - | - | - |
| Surirella sp. | - | - | - | - | - | P | - | P | - | - | - | - | - |
| Gomphonema sp. | - | - | - | - | - | - | P | - | - | - | - | - | - |
| Cocconeis shell | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Cocconeis sp. | - | - | - | - | - | - | - | - | P | - | P | - | - |
| Cymbella (prostrata) | - | - | - | - | - | - | - | - | P | - | - | - | P |
| Cymbella shell | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Stauroneis shell | - | - | - | - | - | - | - | - | - | P | - | - | - |
| Gyrosigma attenuatum | - | - | - | - | - | - | - | - | - | - | C | - | - |
| Shells | - | - | - | P | - | - | - | - | - | - | - | - | - |

## TABLE C-I-V (continued)

### QUALITATIVE COLLECTIONS OF ATTACHED ALGAE FROM STATIONS ON THE SAVANNAH RIVER AND TRIBUTARIES, AUGUST - SEPTEMBER, 1970

| | STATIONS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CENTRICS | BC-6 | HC-35 | LHC-31 | LHC-33 | KC-21 | KC-22 | KC-24 | SC-10 | LSC-94 | S-47A | S-71A | S-72A | S-76A |
| *Melosira* (*herzogii*) | - | - | - | - | - | - | - | A | - | - | - | - | - |
| *M*. (*varians*) | - | - | - | - | - | - | - | - | - | P | - | - | - |
| *M*. sp. | - | - | - | - | - | - | - | - | - | - | C | - | - |
| *Cyclotella* shell | - | - | - | - | - | - | - | - | - | P | - | - | - |

## TABLE C-I-VI

## STANDING CROP AND DIVERSITY OF MACROINVERTEBRATES COLLECTED WITH ARTIFICIAL SUBSTRATE SAMPLERS FROM THE SAVANNAH RIVER

| STATION | NUMBER SPECIES | NUMBER IND. | INDEX OF DIVERSITY | EQUITABILITY COEFFICIENT ("E") |
|---|---|---|---|---|
| S-73A | 20 | 73 | 3.48 | 0.80 |
| S-73A | 14 | 62 | 3.15 | 0.93 |
| S-73E | 14 | 26 | 3.27 | 1.00 |
| S-73E | 12 | 85 | 2.86 | 0.83 |
| MEAN | | 62 | 3.19 | 0.89 |
| S-51A | 16 | 70 | 3.32 | 0.88 |
| S-51A | 20 | 233 | 2.83 | 0.50 |
| S-51E | 17 | 121 | 2.83 | 0.59 |
| S-51E | 11 | 88 | 2.25 | 0.54 |
| MEAN | | 128 | 2.81 | 0.63 |
| S-75A | 23 | 690 | 3.23 | 0.56 |
| S-75A | 20 | 379 | 3.04 | 0.55 |
| S-75E | 18 | 144 | 2.75 | 0.50 |
| S-75E | 9 | 75 | 2.31 | 0.78 |
| MEAN | | 322 | 2.83 | 0.60 |
| S-53A | 33 | 455 | 3.90 | 0.67 |
| S-53A | 20 | 185 | 3.36 | 0.75 |
| S-53E | 17 | 143 | 3.14 | 0.76 |
| S-53E | 15 | 153 | 2.98 | 0.73 |
| MEAN | | 234 | 3.34 | 0.73 |
| S-76E | 19 | 122 | 3.30 | 0.74 |
| S-76E | 21 | 116 | 3.31 | 0.67 |
| MEAN | | 119 | 3.30 | 0.70 |
| S-78A | 14 | 35 | 2.10 | 0.43 |
| S-78A | 11 | 38 | 2.53 | 0.73 |
| S-78E | 16 | 103 | 2.82 | 0.62 |
| S-78E | 18 | 131 | 2.98 | 0.61 |
| MEAN | | 77 | 2.61 | 0.60 |

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See bottom of next page.

### TABLE C-I-VI (continued)

### STANDING CROP AND DIVERSITY OF MACROINVERTEBRATES COLLECTED WITH ARTIFICIAL SUBSTRATE SAMPLERS FROM THE SAVANNAH RIVER
### (July 1, 1970 - September 8, 1970)

| STATION | NUMBER SPECIES | NUMBER IND. | INDEX OF DIVERSITY | EQUITABILITY COEFFICIENT ("E") |
|---|---|---|---|---|
| S-58A | 19 | 141 | 3.26 | 0.74 |
| S-58A | 14 | 158 | 2.86 | 0.71 |
| S-58E | 18 | 258 | 2.16 | 0.33 |
| S-58E | 15 | 154 | 2.36 | 0.47 |
| MEAN | | 178 | 2.66 | 0.56 |
| S-82A | 20 | 141 | 3.14 | 0.65 |
| S-82A | 26 | 273 | 3.04 | 0.42 |
| MEAN | | 207 | 3.09 | 0.53 |
| S-84E | 21 | 275 | 2.68 | 0.43 |
| S-84E | 22 | 253 | 2.90 | 0.45 |
| MEAN | | 264 | 2.79 | 0.44 |
| S-86A | 10 | 67 | 2.39 | 0.70 |
| S-86A | 15 | 86 | 2.81 | 0.67 |
| S-86E | 15 | 240 | 1.39 | 0.20 |
| S-86E | 12 | 192 | 1.52 | 0.33 |
| MEAN | | 146 | 2.03 | 0.48 |
| S-87A | 11 | 511 | 1.62 | 0.36 |
| S-87A | 12 | 286 | 1.79 | 0.42 |
| MEAN | | 398 | 1.70 | 0.39 |
| S-89A | 15 | 386 | 2.34 | 0.47 |
| S-89A | 11 | 387 | 1.46 | 0.27 |
| S-89E | 21 | 487 | 2.62 | 0.38 |
| S-89E | 22 | 540 | 2.22 | 0.27 |
| MEAN | | 450 | 2.16 | 0.35 |

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Samplers at stations 558, 582, 584, 586, 587, and 589 exposed from August 1, 1970 - September 8, 1970.

## TABLE C-I-VI (continued)

### STANDING CROP AND DIVERSITY OF MACROINVERTEBRATES COLLECTED WITH ARTIFICIAL SUBSTRATE SAMPLERS FROM THE SAVANNAH RIVER

| STATION | NUMBER SPECIES | NUMBER IND. | INDEX OF DIVERSITY | EQUITABILITY COEFFICIENT ("E") |
|---|---|---|---|---|
| S-66E | 18 | 1526 | 2.65 | 0.50 |
| S-66E | 21 | 1458 | 3.03 | 0.52 |
| MEAN | | 1492 | 2.84 | 0.51 |
| | | | | |
| S-69A | 20 | 483 | 2.71 | 0.45 |
| S-69A | 30 | 789 | 2.53 | 0.27 |
| S-69E | 32 | 3653 | 2.50 | 0.25 |
| S-69E | 16 | 804 | 2.72 | 0.56 |
| MEAN | | 1432 | 2.62 | 0.38 |

MR. LITTLE: Those of you who have copies of the report, Mr. Traina mentioned that there are some additional copies available. There are a limited number and I would say perhaps it would be better to leave your name and we will mail additional copies to you as more are made available.

At this time I would like to read the introduction, summary and conclusions, and recommendations of this report.

> A water quality survey of the Savannah River from 7 miles north of Augusta, Georgia, to approximately 75 miles southeast of Augusta was conducted during July-August 1970. The survey included the identification of waste sources and water quality in the main stem and major tributary streams in both Georgia and South Carolina. Water quality on tributary streams within the AEC Savannah River Plant area was examined during October 1970.

Mr. Chairman, I have three posters on the tripod right now that I would like to introduce into the record for visual purposes, if this is permissible.

MR. WHITE: You have these in reduced form so that we can incorporate it, I assume, Mr. Little?

MR. LITTLE: That is correct. Each of these is included in the report itself.

MR. WHITE: Well, just to clarify it, it is already in the record and we won't have any problems, if you will just refer to it and refer to the particular part of the report.

MR. LITTLE: O. K.

I believe that this first figure that I put up on the tripod is Figure 1 in the report. It is the general location of the study area and available for anyone to look at if they so desire.

> This survey was requested by the Georgia Water Quality Control Board and concurred with by the South Carolina Pollution Control Authority. Extensive assistance was provided by both agencies during the planning and operations phases of this project. Full cooperation was received from the Atomic Energy Commission, as well as the numerous municipal and industrial entities examined. The Savannah District of the U. S. Army Corps of Engineers provided valuable information on the hydrological characteristics of the Savannah River. The successful completion of this report could not have been accomplished

without the contributions of these agencies, and their assistance is gratefully appreciated and acknowledged.

The summary, conclusions, and recommendations have been revised to reflect information available to the Environmental Protection Agency as of February 1972. The body of the report has not been revised and it is recognized that conditions may have changed since the report was first written. Accordingly, in a few instances statements in the summary, conclusions, and recommendations may differ from those of the text.

At this point I would like to make the information available for the conferees that the summary, conclusions and recommendations are the pertinent section of this report.

Summary and conclusions:

The current Georgia fecal coliform bacteria criteria of 5,000/100 ml was exceeded from just north of the city of Augusta and Hawks Gully outfalls to downstream of Spirit Creek, a distance of 18 miles. Except for locations upstream from all waste sources, pathogenic Salmonella were isolated at all Savannah River stations in the 74-mile reach sampled.

Dissolved oxygen below 5.0 mg/l was not detected in the Savannah River during the period of this study. However, a diurnal study of dissolved oxygen showed that wastes originating in the reach of the river between Hawks Gully and Horse Creek were of sufficient magnitude to noticeably reduce the oxygen assets of the Savannah River.

1. The Savannah River, middle reach, receives daily wastes with a 5-day biochemical oxygen demand of 73,200 pounds. These wastes are equivalent to the untreated waste discharged by a human population of 439,000. Sixty-one percent of the waste loads measured are from Georgia sources. The remaining 39 percent are from sources located in South Carolina.

2. The major sources of wastes originating in Georgia enter the Savannah River from the city of Augusta, Columbia

Nitrogen Corporation, the Olin Mathieson Corporation, and grossly polluted flow from Butler Creek, Hawks Gully and Spirit Creek.

3. It is estimated that only about 45 percent of the total municipal water supply for the Augusta, Georgia, area reaches the sewage treatment system. Approximately 12 million gallons per day of wastes are routed through the Augusta sewage treatment plant, a primary facility, with $BOD_5$ removal efficiencies less than 40 percent. This particular summary statement has been revised to reflect recent information.

4. Columbia Nitrogen Corporation Caprolactum Plant discharges approximately 3,000 pounds per day of $BOD_5$ directly to the Savannah River. This waste exhibits toxic or growth inhibiting characteristics. A total nitrogen load of 3,700 pounds is also discharged daily to Beaverdam Ditch from the nitrogen plant.

5. Olin Corporation discharges less than a quarter of a pound per day of mercury.

A study in June of 1971 indicated that the mercury level was 0.04 of a pound per day.

6. Meaningful coliform bacteria density in Hawks Gully outlet was 20,000/100 ml and Salmonella organisms, which are pathogenic to man and other warm-blooded animals, were isolated.

7. Butler Creek, at the confluence with the Savannah River, contained an average dissolved oxygen of only 0.5 mg/l, $BOD_5$ of 47.9 mg/l, and fecal coliform bacteria density of 5,900,000/100 ml.

8. Indirect drainage to Butler Creek from Camille Ditch, Rocky Creek, Gwinnett Street Ditch, and Oates Creek contained dissolved oxygen concentrations of zero, 1.4, zero, and 4.0 mg/l respectively. The upper reach of Beaverdam Ditch, a tributary to Butler Creek, had undetectable dissolved oxygen, 173 mg/l of $BOD_5$, and a mean fecal coliform bacteria density of 9,300,000/100 ml. The other Butler Creek tributary, Phinizy Creek, receives up to 8,470 pounds per day of $BOD_5$ from the

Augusta sewage treatment plant.

9. Spirit Creek receives daily 1.7 million gallons of secondary treated chlorinated effluent from the Fort Gordon sewage treatment plant. It also receives 11,300 pounds of $BOD_5$ from Continental Can Paper Mill. Dissolved oxygen downstream from the paper mill discharge averaged 0.1 mg/l and $BOD_5$ 22 mg/l. This discharge increased the color in Spirit Creek from 57 to 472 color units. This particular summary statement was revised to reflect recent information. Previously the discharge from Fort Gordon was not coordinated.

10. Major waste discharges entering the Savannah River from South Carolina are from the city of North Augusta, Kimberly Clark, the Atomic Energy Commission's Savannah River plant, and grossly polluted flow from Horse Creek and lower Three Runs Creek.

11. The city of North Augusta has no waste treatment facilities. Raw wastes discharged directly into the river contained pathogenic Salmonella and a mean fecal coliform bacteria

density of 24,000,000/100 ml.

12. The daily discharge from Kimberly Clark Paper Company waste lagoons contained 450 pounds of $BOD_5$, 575 pounds suspended solids, and a mean fecal coliform bacteria density of only 170/100 ml.

13. Waste treatment facilities at the AEC Savannah River plant consist of waste stabilization ponds and septic tanks.

14. The cities of Aiken and Warrenville and the Gregg Mill, Bath Mill, Seminole Mill, Valchem Chemical Company, and Clearwater Finishing Plant discharge 55,000 pounds of $BOD_5$ to Horse Creek and its tributaries. Approximately 23,000 pounds of this wasteload reaches the Savannah River.

15. Bottom muds in Horse Creek near the confluence with the Savannah River contained 990 mg/kg of chromium which is toxic to bottom organisms and destroys fish and spawning areas. Approximately 305 pounds per day of chromium flow into the Savannah River from Horse Creek.

At this point I would mention that recent observations have shown that a kaolin mining operation on Horse Creek near

South Carolina Highway 125 seems to discharge highly turbid flow from its operations. This is only an observation at this point and I think it does need further investigation.

> 16. Sludge deposits in the Savannah River downstream from Horse Creek contain 670 mg/kg of chromium while immediately upstream chromium concentrations were only 32 mg/kg.
>
> 17. The J. P. Stevens Mill in Allendale County discharges sanitary and wool scouring wastes into Davis Branch, a tributary to Lower Three Runs Creek. At the time of the study, this waste had a population equivalent of 43,000 and severely degraded the water quality in Lower Three Runs Creek. South Carolina Pollution Control Authority Order No. 70-4-W issued March 11, 1970, called for a cessation of their pollution and construction of adequate waste treatment facilities by March 23, 1971.

There are two additional charts that I will use for reference purposes if you care to examine them.

The first is a schematic showing the tributaries and the major waste sources in the study area and is identical to one of the figures in the report.

The third, which is also a figure in the report, shows the relative amounts of fecal coliform pollution entering the river from the various sources in the study area.

Conclusions:

Discharges of untreated and inadequately treated municipal and industrial waste originating in Georgia and South Carolina cause interstate pollution of the Savannah River, middle reach, endangering the health and welfare of persons in both States. This pollution is subject to abatement under the provision of Section 10 of the Federal Water Pollution Control Act as amended, 33 USC 1160.

1. Untreated waste discharges from the sewer system serving downstream Augusta, Georgia, and North Augusta, South Carolina, contribute fecal coliform bacteria contamination to the interstate waters of the Savannah River.

2. None of the wastes discharged to the Savannah River from the Augusta, Georgia, sewage treatment plant are receiving adequate treatment.

3. Chromium deposits causing

interstate pollution of the Savannah River result from waste discharges from the Gregg Mill, Valchem Chemical Company, and Clearwater Finishing Plant.

4. Butler Creek, at the confluence with the Savannah River, is grossly polluted by the discharge of 12 MGD of inadequately treated municipal waste from the Augusta sewage treatment plant and from grossly polluted interior drainage from the Augusta, Georgia, area. This particular conclusion has been revised to reflect recent information.

5. Oates Creek, Camille Ditch, Rocky Creek, Phinizy Ditch, and Beaverdam Ditch receive untreated and inadequately treated municipal and industrial wastes from the Augusta, Georgia, area and are little more than open sewers.

At this point, Mr. Chairman, I think we can expect to hear some updated reports on the status of pollution from both Georgia and South Carolina which may render some of this information somewhat out of date.

6. Spirit Creek is grossly polluted

by the discharge from the Continental Can Paper Mill. This particular conclusion has also been revised to reflect recent information. Chlorination of the Fort Gordon wastes has been provided since our study in 1970.

7. Horse Creek and its tributary, Little Horse Creek, are grossly polluted from the discharge of more than 11 MGD/day of untreated textile mill wastes and more than 1.3 MGD/day of raw and inadequately treated sanitary wastes.

8. Water quality in Horse Creek violated water quality standards adopted by South Carolina.

9. Kimberly Clark Company was providing adequate treatment for its wastes and the effluent did not have a measurable effect on water quality in the Savannah River.

10. Organic wastes and thermal discharges receiving inadequate treatment from facilities serving the AEC Savannah River Plant cause localized water quality degradation in plant tributaries with no noticeable effect on water quality in the Savannah River.

Recommendations.

It is recommended that:

1. The city of Augusta upgrade the Butler Creek sewage treatment plant to secondary treatment with a minimum of 85 percent 5-day BOD removal by June 1973. All wastes now being discharged without treatment, either directly to the Savannah River or to the existing city collection system, be transported to the Butler Creek sewage treatment plant by June 1973. Effective disinfection of plant effluent be provided at all times.

2. The city of Augusta and the county of Richmond, Georgia, enforce their sewer use ordinances.

3. The city of Augusta institute a program of separating existing combined storm and sanitary sewers and extending collection and interceptor lines to all sections of the Augusta, Georgia, metropolitan area. A report on the feasibility of the sewer separation program be submitted to the conferees by January 1, 1973.

4. The Columbia Nitrogen Corporation

caprolactum plant and nitrogen plant provide the equivalent of secondary treatment to their wastes by December 1972.

5. The Continental Can waste treatment lagoons be upgraded to provide at least 85 percent reduction of organic wastes by December 1972. These lagoons should discharge directly into the Savannah River instead of into Spirit Creek. When applied technology becomes available, the color in the effluent should be reduced to background in the Savannah River at the point of discharge.

6. The city of North Augusta, South Carolina, install and operate satisfactory secondary waste treatment facilities as required by the South Carolina Pollution Control Authority under Order 70-10-W issued April 21, 1970.

7. The J. P. Stevens Company install and properly operate waste treatment facilities to remove at least 85 percent of their inorganic waste by April 30, 1972.

8. The Gregg Mill of the Graniteville Textile Company, the Valchem Chemical Company, and the Clearwater Finishing Plant, subsidiaries

of United Merchants and Manufacturing Company, immediately eliminate chromium from their waste discharges.

9. A feasibility study report for a waste collection system and a centralized waste treatment facility for the entire Horse Creek Valley be submitted to the conferees by December 31, 1972. Discharge from this facility will be directly to the Savannah River.

10. The Atomic Energy Commission's Savannah River Plant provide secondary treatment of domestic wastes in accordance with Executive Order 11507. These facilities should be operational by December 1972.

11. The States of Georgia and South Carolina develop consistent water use classifications and water quality criteria for the Savannah River.

12. The State of Georgia classify all major tributary streams to the Savannah River. Discharge limits for industrial sources be established by the Environmental Protection Agency in cooperation with the State of Georgia through the

1899 Refuse Act Permit Program to insure that water quality criteria will be met.

13, and finally. Discharge limits be established for Horse Creek industrial waste sources by the Environmental Protection Agency in cooperation with the State of South Carolina through the 1899 Refuse Act Permit Program to insure that established water quality criteria are met.

Mr. Chairman, that concludes my presentation.

MR. WHITE: Thank you, Mr. Little.

I would like to make one minor clarification with respect to something that happened that ties, of course, into the report in a press release that was put out relative to the conference.

Under Summary Statement 10, Kimberly Clark was listed as a major waste discharger. In a press release that was put out this was translated to be a major waste source.

Now, as Mr. Little proceeded, the indication was there that Kimberly Clark now has adequate treatment, so we didn't want to wave the flag or beat anybody over the head who is doing a good job and I would like to just point this out.

MR. LITTLE: It is strictly a matter of semantics.

In terms of quantity they have a large discharge. In terms of quality, our Conclusion No. 9 covers it.

MR. WHITE: The point being that the press release changed the words around slightly,but copied, apparently, from the summary statement.

I have one question, Mr. Little, I would like to go into.

In the report there is an indication that in the vicinity of Hawks Gully where there are no known point sources of pollution we are getting high coliform counts with Salmonella. Do you have any explanation at all for this or do you think additional work should be done in that area to see if the sources can be pinpointed?

MR. LITTLE: As I understand the Hawks Gully area, it is also the recipient of stormwater runoff from the municipal area of Augusta and this could possibly be the reason. Now, Mr. Carroll, our bacteriologist responsible for this section of the report, is here and I would perhaps ask him that same question if you would like him to come up.

MR. WHITE: Well, fine, if Mr. Carroll could come up, it may help.

MR. LITTLE: This is Mr. Bobby J. Carroll, Chief of our Microbiology Branch in the Surveillance and Analysis

Division.

BOBBY J. CARROLL, CHIEF
MICROBIOLOGICAL SERVICES
U.S. ENVIRONMENTAL PROTECTION AGENCY
ATHENS, GEORGIA

MR. CARROLL: It was my understanding, Mr. Chairman, that there was some evidence of combined sewers in this area, in the general area. Also that the fact is that these bacteria could have originated from stormwater runoff in the general area here and certainly from any combined sewers that might be in the area.

MR. WHITE: I assume that we will address this, then, further along in the program, in all probability, when the Georgia presentation is made.

MR. CARROLL: Yes, sir.

MR. WHITE: Are there other comments or questions?

Mr. Howard.

MR. HOWARD: I would say for the record that we don't agree with all the conclusions, but we will work that out in sort of a little infighting later.

I would like to ask Mr. Carroll if he wouldn't be surprised if you didn't find Salmonella where you have got people, chickens, ducks and stuff?

MR. LITTLE: I would answer that question in the affirmative.

MR. HOWARD: We don't have any epidemiologist who says we have got any cases of Salmonellosis, do we? But if you look enough you are going to find Salmonella even in some of our primitive areas of Georgia. And I wish you microbiologists would quit talking about Salmonella all the time unless they can find some cases.

MR. LITTLE: I think the intent is that it indicates potential hazard--

MR. HOWARD: We haven't got to that, too.

MR. LITTLE: --and if we didn't find them we would be surprised.

MR. TRAINA: Could I comment on that? You say if you didn't find them you would be surprised? In other words, it would be normal in other areas, Salmonella, a microorganism that you normally find in areas that are or are not subject to sewage discharges?

MR. LITTLE: Sources of Salmonella are ubiquitous in terms of not only human pollution but animal pollution as well and we expect to find them. The reason that we do check is to see if there is that potential there and this is a qualitative examination, and if you do find a Salmonella, that is a pathogen and the potential for a health hazard is in that area. But this is true of surface waters, I think, all over the State.

MR. HOWARD: If you don't find them it doesn't mean anything, if you don't find them.

MR. CARROLL: If you didn't find them I would say that you would have an extremely clean water, probably, if you didn't find them consistently.

MR. HOWARD: If you look long enough over the watershed where you have chicken, ducks, and people you are going to find them.

MR. TRAINA: I saw in the report that you did look at various species of general Salmonella. Were they pathogenic species determined?

MR. LITTLE: That is correct.

MR. TRAINA: You found these in a number of places throughout the Savannah River, I think,including the water intake?

MR. LITTLE: Yes. I believe these were located at all stations on the Savannah River, including the stations closest to the Augusta and North Augusta water intakes.

MR. TRAINA: And you just concluded that it is a potential health hazard?

MR. LITTLE: This is correct. Of course at a water supply intake this is subject to additional treatment before consumption.

MR. TRAINA: Did you investigate finished water in your investigation?

MR. LITTLE: Not to my knowledge.

MR. HOWARD: They had no epidemiology either.

MR. LITTLE: I understand now that finished water was examined without the presence of Salmonella being detected.

MR. TRAINA: Apparently the water treatment took care of the Salmonella?

MR. LITTLE: From our examination that is right.

MR. TRAINA: I have a couple other questions, Mr. Little.

You indicate here that 45 percent of the total municipal supply reaches the sewage treatment plant. I assume then that the other 55 percent is taking care of septic tanks and just direct discharges, is that the implication?

MR. LITTLE: The other 55 percent I would imagine go in a various number of ways, through consumption, use of septic tanks. I am not aware--there might be some raw discharges involved; I am not aware of this particular fact. This might be brought out by the State later.

MR. TRAINA: Do you know how much of the area of Augusta is sewered actually, percentagewise?

MR. LITTLE: Personally I am not aware of that.

MR. HOWARD: We will cover that, Paul.

MR. TRAINA: I assume that same item reflects this indirect drainage statement in your summary Item No. 8 regarding Butler Creek and the other ditches going into Butler Creek, that apparently there are a lot of areas or significant amount of areas that have direct discharges either through septic tanks or directly that are not connected to a sewer system that are contributing to these gross numbers we see here in Camille Ditch and Rocky Creek, and so on?

MR. LITTLE: I think this is implied and in addition reference is implied that stormwater runoff from urban areas are sources of pollution.

MR. TRAINA: Well, what I was getting at, Alec, is that is it just normal urban runoff or is it in fact areas that are not connected to a sewer system that are contributing?

MR. LITTLE: Personally I don't know the answer to that. Again I think the State might.

MR. HOWARD: Both, really, Paul. We will cover some of that in our statement.

MR. LEDBETTER: We will clarify that.

MR. TRAINA: Alec, you mentioned, and it is not in the report, this question of kaolin mining, I assume possibly contributing chromium to the Savannah River, was this the implication here?

MR. LITTLE: The implication was based on an observation of yesterday and I think what may have happened, during the period of the study, this particular mining operation may not have been operating. The observation that was made was made at the bridge on South Carolina 125 on Horse Creek Crossing and the observation was that the stream was extremely turbid, seemingly from mining operations which were immediately upstream from this bridge. Now, without further investigation I wouldn't say that this could be positively stated at this point, but it was fairly obvious.

Now, Horse Creek is noted for its pollution problems and the color of highly turbid suspended matter in the stream clouded the issue in terms of the normal pollution that you see, so it was a different phenomenon than what we had previously observed.

MR. TRAINA: But would you expect, if in fact you had a discharge from kaolin mining operation, that that discharge would contain chromium?

MR. LITTLE: I would imagine there are trace elements of all types in this waste. Chromium I wouldn't be certain without examination. I know kaolin operations, kaolin itself is very high in aluminum, but I am not certain about chromium in terms of really being a pollutant.

MR. TRAINA: Then you would say that the chromium you found in the muds in the Savannah River and in Horse Creek was primarily due to industrial discharges into that Horse Creek area?

MR. LITTLE: Yes, I would say that. I think that many of the dyes used in textile operations are chromium-based dyes or at least contain chromium in them and this is what I would consider the primary source of chromium.

MR. TRAINA: One question and again maybe the AEC individual will comment on this. You talk about the AEC River Plant and you discuss or conclude that they are causing localized water quality degradation of plant treatment areas. Would you just give us some idea of the extent of that degradation in terms of oxygen, coliform, temperature?

MR. LITTLE: I am not certain whether this is discussed in detail in the report and again I am not personally aware of the extent of this problem. If you might give me a minute or two, let me check and see.

There is a section of the report that seemingly goes into detail on the quality problems that they do have in the Lower Three Runs Creek area.

MR. TRAINA: Would you say that these are significant in terms of dissolved oxygen depression or high bacterial levels or whatever other parameters?

MR. LITTLE: Without a detailed examination I would be hesitant to say that. My guess would be yes, they are.

MR. TRAINA: That is all the questions I have.

MR. TINSLEY: Mr. Chairman, I have a question.

MR. WHITE: Mr. Tinsley.

MR. TINSLEY: Mr. Little, have your staff members performed any additional chromium analyses since this study was conducted?

MR. LITTLE: I believe not, Mr. Tinsley.

MR. TINSLEY: In the conclusions I think it would be appropriate if we rectified No. 7 in that it infers that 11 MGD of untreated textile mill wastes are discharged to Horse Creek. I would readily admit that it is inadequately treated, but it is not untreated. Treatment has been provided and I think in our report we will bear this out as to its effect on the chromium concentration.

I think it is well for us to recognize that most of the field work with respect to this report is approximately 2 years old and circumstances have certainly changed since then.

MR. LITTLE: That is correct. This was the reason that I interjected that one statement that I thought some of this information would be updated. I am aware of a treatment system for the Gregg Mill waste, I believe, that is rather recent--in fact, very new.

MR. WHITE: I might interject, I am sure that after the conferees go into executive session there will be many changes in the conclusions and recommendations and this is not a slam or slap at Mr. Little, but it invariably happens this way. Once you get here and get additional information presented from many sources, then usually you wind up with substantial revisions.

MR. LITTLE: I would hope that pollution control is ongoing between the time we do a survey and when we have a conference.

MR. WHITE: Any other comments?

Thank you, Mr. Little.

MR. TRAINA: Mr. Chairman, as just indicated by the last comments, there needs to be some updating, obviously.

I would like to now call, so we can get some of this update on our municipal and industrial situation, two additional EPA representatives. The first, Mr. Asa Foster, who is Director of our Federal Facilities Program in Atlanta, to discuss the situation or status on municipal waste treatment as it relates to the 660 construction grants activities.

ASA B. FOSTER, JR.
DIRECTOR, FACILITIES BRANCH
AIR & WATER DIVISION
U. S. ENVIRONMENTAL PROTECTION AGENCY
ATLANTA, GEORGIA

MR. FOSTER: Mr. Chairman, I have a statement here and I would simply like to summarize the statement, but have it all put in the record.

MR. WHITE: Fine, it will be accepted into the record as if read.

(The above-mentioned statement follows:)

# Report on Status of Construction Grant Projects
# In The Middle Reach of the Savannah River
# Georgia & South Carolina

Statement made by Asa B. Foster, Jr., Director, Facilities Branch,
Air & Water Division, EPA, Region IV
Enforcement Conference, Augusta, Georgia on March 22, 1972

## Report on Status of Construction Grant Projects In The Middle Reach of the Savannah River Georgia & South Carolina

There are six (6) construction grant projects in the area covered by the Conference; four (4) of these in Georgia and two (2) in South Carolina. See Figure 1 attached. The following is the status of the Georgia projects:

> Three (3) projects involved in Augusta sewage treatment plant and interceptor sewers in Augusta and Richmond County which discharge to the Augusta treatment plant. (GS-79, GA-170, & GA-250) The fourth project consists of interceptor sewers and two treatment plants in the Reedy Creek drainage basin in Columbia County (GA-184).

WPC-GA-79, Augusta

Grant Offer dated February 25, 1963

Amount of Grant - $600,000; later revised to $907,600

Eligible Cost - $3,843,065.08

Current outstanding payment to the City - $100,000

(Note: This is a multi-municipal project with both the municipalities limited to a maximum of $600,000)

23 MGD primary treatment plant

The original grant for primary treatment was in accordance with existing regulations. The approval of plans and specifications for the primary plant was contingent upon Augusta providing secondary treatment in accordance with a schedule submitted November 17, 1966. This schedule contemplated completion of secondary treatment by September, 1971.

The reasons for withholding funds were:

1. To get better operation & maintenance.
2. To insure that appropriate plans for secondary treatment facilities were being initiated.

### WPC-GA-170, Richmond County

Eligible Cost - $1,355,130

Grant Amount - $367,220

Project is for interceptor sewers in the Butler Creek drainage area.

Construction was completed in May, 1970.

Final payment will not be made on this project until the Augusta secondary treatment facilities are under construction.

We have tentatively approved the eligibility of sewers in the Rocky Creek drainage area. However, this change has not been made in the project.

WPC-GA-250, Augusta

Eligible Cost - $3,017,000

Grant Amount - $995,610

Grant Offer made on December 24, 1970

Project description: Expansion and upgrading of 23 MGD primary treatment plant to a 29 MGD activated sludge treatment plant with disinfection.

Plans and specifications were approved by the State on February 16, 1972 and by our office on March 20, 1972.

Construction Time - 400 days.

WPC-GA-184, Columbia County

Eligible Cost - $1,516,400

Grant Amount - $500,410

Project consists of two secondary treatment facilities and related interceptor sewers.

A 0.5 MGD oxidation ditch treatment plant with chlorination to serve the Crawford Creek drainage area is now under construction. This plant and interceptor will eliminate an existing package plant and a septic tank. The plant will discharge to Crawford Creek which discharges to the Savannah River via Tudor Branch, Uchee Creek, and Little River. The treatment plant and interceptors are near completion (latest estimates submitted us show plant 49% complete and sewers 78% complete).

A 1.7 MGD contact stabilization plant with chlorination is being built to serve the Reed Creek drainage area. The treatment plant and sewers will eliminate seven package plants. The treatment plant will discharge to Reed Creek, a tributary of Augusta Canal. Plans for the interceptor were approved by EPA on January 11, 1972. Treatment plant plans were approved on March 20, 1972.

The needs list indicates a future project for Augusta estimated to cost $524,000 for interceptor sewers is pending.

To date, the South Carolina Pollution Control Authority has submitted two (2) projects which are in the area of the subject Enforcement Conference. Further discussion with South Carolina Pollution Control Authority officials on Friday, March 17, 1972 revealed that there are no additional projects pending in their office at this time.

The two (2) projects submitted to date are for North Augusta and Aiken.

WPC-SC-215, North Augusta

Grant Offer - September 2, 1970

Total Cost - $1,243,000

Eligible Cost - $1,218,000

Grant Amount (33%) - $365,400

Project is for 3.22 MGD trickling filter sewage treatment plant with lift station and interceptor sewer.

Plans and specifications have not been received. City presently discharges untreated sewage to the River.

WPC-SC-262, Aiken

Grant application received by EPA.

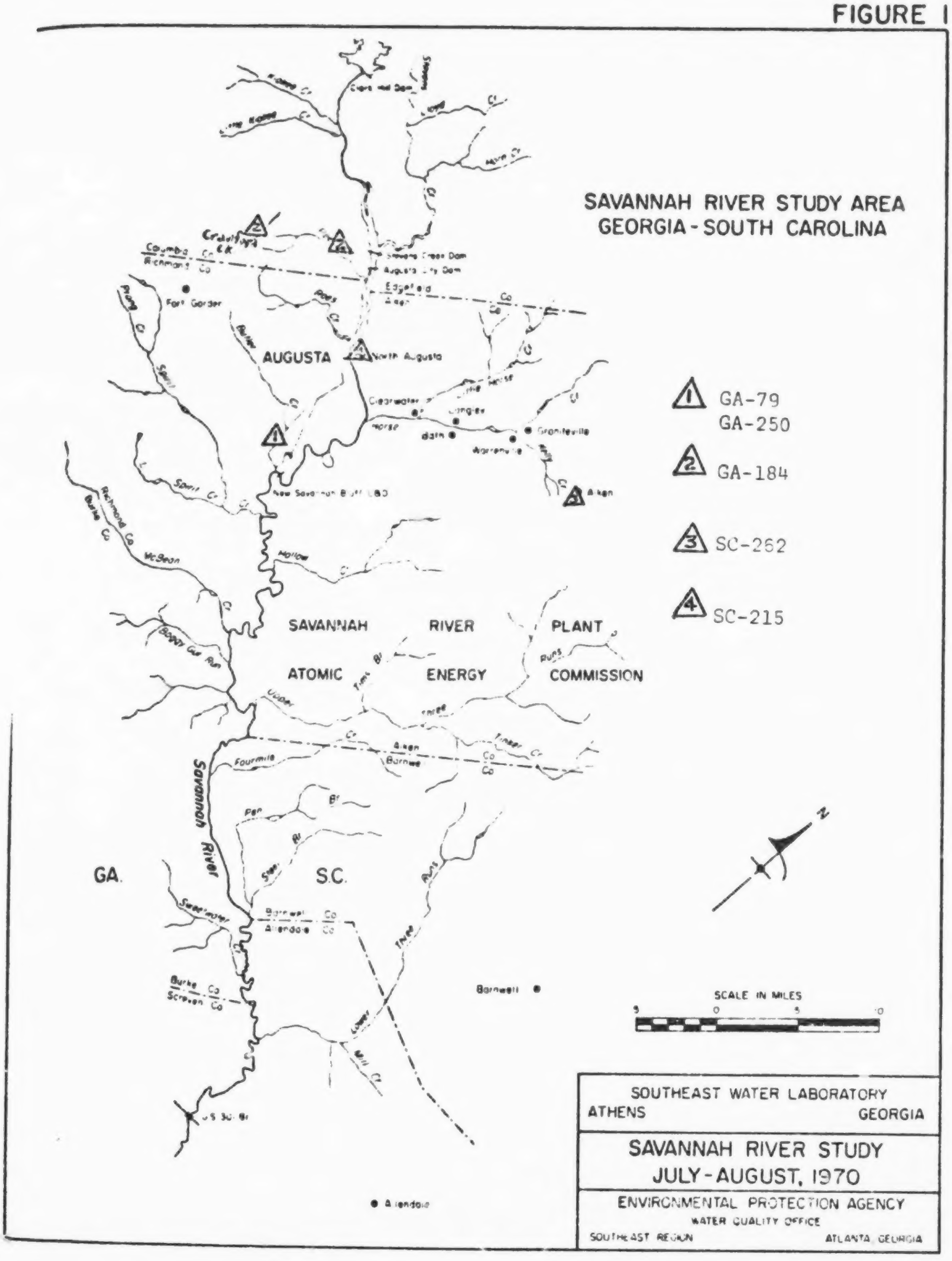
Proposed project is to increase size of existing facility from 1.0 MGD standard rate trickling filter to 3.0 MGD high rate trickling filter.

A grant offer for this project will not be considered until an approvable interim plan has been submitted addressing the entire Horse Creek Valley Area.

On the present 5-year list are the following projects:

1. Bath - secondary treatment - $200,000 project cost - 1972
2. Clearwater - secondary treatment - $200,000 project cost - 1973.

FIGURE I


SAVANNAH RIVER STUDY AREA
GEORGIA - SOUTH CAROLINA
GA-79
GA-250
GA-184
SC-262
SC-215
Clark Hill Dam
Stevens Creek Dam
Augusta City Dam
Columbia Co
Richmond Co
Edgefield Co
Aiken Co
Fort Gordon
AUGUSTA
North Augusta
Clearwater
Langley
Bath
Graniteville
Warrenville
Aiken
New Savannah Bluff L&D
Spirit Cr
McBean
Richmond Co
Burke Co
Hollow Cr
Boggy Gut Run
SAVANNAH RIVER PLANT
ATOMIC ENERGY COMMISSION
Upper Three Runs
Tims Br
Fourmile
Aiken Co
Barnwell Co
Tinker Cr
Savannah River
Pen Br
Steel Br
GA.
S.C.
Sweetwater
Barnwell Co
Allendale Co
Burke Co
Screven Co
Lower Three Runs
Mill Cr
Barnwell
Allendale
U.S. 301 Br
N
SCALE IN MILES
5 0 5 10
SOUTHEAST WATER LABORATORY
ATHENS GEORGIA
SAVANNAH RIVER STUDY
JULY-AUGUST, 1970
ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
SOUTHEAST REGION ATLANTA, GEORGIA

MR. FOSTER: We have examined our records and have found that there are six construction grants projects in the conference area. Four of these are in Georgia and two in South Carolina. Three of the projects in Georgia are connected with the Augusta Sewage Treatment Plant.

One project is Georgia No. 79, on which we made a grant in 1963 in the amount of $600,000. This grant was later updated to $907,600, since it was a multiple municipal grant with Richmond County. This was for a 23 MGD primary sewage treatment plant. Currently we are withholding $100,000 of this grant payment. The plant was completed. There was a little problem with getting proper operation and maintenance and also we are waiting for them to begin a secondary treatment plant.

One of the related projects is our Project No. 170, Richmond County, which we made a grant in the amount of $367,220, and the plant was completed in May of 1970. We have not paid this grant off completely pending the commencing the construction of the secondary treatment plant.

We have made a grant on our Project No. 250, which is for the secondary treatment plant of Augusta. The grant amount is $995,610 made in December 1970. This project will be for the expansion and upgrading of the plant from a 23 MGD primary plant to a 29 MGD activated sludge treatment plant with disinfection. The State approved the plans and specifications on February 16, 1972, and our office approved these on March 20, 1972. Construction time is estimated or is listed as 400 days.

In Columbia County we have one project, No. 184, grant amount of $500,000. This consists of interceptor sewers and two treatment plants, one treatment plant on Crawford Creek and one plant on Reedy Creek.

The facility on Crawford Creek is about 50 percent complete, the sewer is about 50 percent complete and the--I beg your pardon. The plant is 49 percent complete and the sewer is 78 percent complete.

The facility on Reedy Creek, the plans were approved on March 20, so that has not yet been placed under construction.

We do list a need in the Augusta area for additional interceptor sewers. These appear on the 5-year needs list of some $524,000 worth of work.

Going to South Carolina, to date we have only two projects. We made a grant to North Augusta in September 1970. The grant was $365,400 for the construction of a 3.22 MGD trickling filter plant, lift station and interceptor sewer. We have not yet received the plans for this facility.

We have in the office an application from the city of

Aiken, our Project No. 262. This is for a 1.0--the city now has a 1.0 MGD standard rate trickling filter plant which they propose to increase to a 3.0 MGD high rate trickling filter plant. We cannot make the grant offer on this project until we receive an interim plan which will address the problem previously mentioned in the Horse Creek Valley area.

In South Carolina there are two towns listed on the needs list, the town of Bath and the town of Clearwater. We have reason to believe that there are several other dischargers there that should be listed.

MR. WHITE: Thank you, Mr. Foster.

Comments or questions?

MR. TRAINA: Yes.

MR. WHITE: Mr. Traina.

MR. TRAINA: I am sure the State of Georgia will comment on this.

But with regard to the Augusta grant, Asa, you say that you are withholding funds on the basis of getting assurance with regard to plans for secondary treatment facilities. Is this assurance forthcoming, do you know?

MR. FOSTER: Right. We have the plans--plans are approved for the secondary plant. If I may go back just a little bit, the original grant was made in accordance with all laws and regulations at the time which did permit grants on primary treatment plants. Shortly after the grant was made and the plans--when we approved the plans, I believe the State put the requirement on them to come up with secondary treatment and we have been withholding this little money to assure that they would place the secondary under construction.

MR. TRAINA: It is forthcoming?

MR. FOSTER: Right.

MR. TRAINA: It is a profile--

MR. FOSTER: We approved the plans on March 20.

MR. TRAINA: O. K.

MR. WHITE: Mr. Tinsley.

MR. TINSLEY: Asa, can you better identify the additional dischargers that you feel probably should be included on the needs list?

MR. FOSTER: I cannot. Our needs list, first of all, only considered towns of 10,000 population and over unless we had the information. We did not seek it. As I understand it, there are--if I may use the map.

As I understand it, there are several dischargers up here, some of which are domestic waste plants but are not municipal waste plants. Now, I am not sure in my own mind what is what, but the town of Warrenville, Graniteville and Langley, there are some dischargers in that Horse Creek area, all of which are not municipal plants and are small enough that we wouldn't have picked them up in our survey to determine needs.

MR. TRAINA: Asa, one other question. Again, maybe Mr. Tinsley here will comment on it.

With regard to North Augusta, you say you have not received plans and specifications. Do you know in fact, have these been prepared? Is it just a question of getting them to your office?

MR. FOSTER: I understand that they are in the final stages of preparation. I don't know whether the State has them or not.

MR. TRAINA: I assume that we will get a status report on that?

MR. WHITE: Well, I have a comment and question and it might not be proper to ask you, Mr. Foster.

But, now, you stated with respect to the grant application received on Aiken that you would have to have an interim plan addressing the entire Horse Creek Valley area?

MR. FOSTER: This is correct, or the basin. We realize Aiken is some 25 miles, I believe, up Horse Creek or up Kelly Creek from the Savannah River, but there are a number of problems along the river and we need to consider all of the alternatives to Aiken going their own way. It may be that Aiken could help serve some of these other facilities, for example. I mean we don't know that. But a plan should point out these alternatives.

MR. WHITE: Within your knowledge, is there a planning agency with jurisdiction that inclusive?

MR. FOSTER: It was my--

MR. WHITE: Again maybe Mr. Tinsley can get into this when he comes up and this might be unfair.

MR. FOSTER: I think the State should address this because they are in the process, as I understand it, of writing the interim plan for this--

MR. WHITE: Fine. I am sure we can likely explore it more during the presentation from South Carolina.

MR. TRAINA: Mr. Chairman, maybe I can comment again just for the record. Under the 18 CFS 601 regulations all of these projects lack in part a metropolitan and basin plan. There is in existence in Aiken a metropolitan council of governments of Aiken and Richmond Counties that I believe under the State law would be the certified agency to develop such plans in cooperation with the State pollution control authority.

MR. WHITE: Any other comments or questions?

Thank you, Mr. Foster.

Mr. Traina.

MR. TRAINA: Mr. Chairman, I would like now to bring us up to date with regard to the industrial waste part. As you know, Mr. Chairman, the other conferees, EPA is involved in the Refuse Act permit program with the Corps of Engineers to review these permits and I would like to call on Mr. Bill Cloward of EPA's office in Atlanta to give us a status report on the permit situation as regards this study area.

WILLIAM H. CLOWARD
CHIEF, INDUSTRIAL WASTE SECTION
U. S. ENVIRONMENTAL PROTECTION AGENCY
ATLANTA, GEORGIA

MR. CLOWARD: Thank you, Mr. Traina. Mr. Chairman, ladies and gentlemen.

What I would like to do today is to summarize the applications that we have received from the industries who have applied for permits to discharge under the Refuse Act program. Basically 43 industrial firms in Georgia and South Carolina--there are 25 in South Carolina and 18 in Georgia--have applied for permits. We have on hand in our offices right now 39 of these 43. Four of them are still too incomplete to be forwarded from the Corps.

Of these 43 minus the four unknown ones, of the 39 remaining maybe I should say, according to the applications 30 of the industrial plants have no treatment, although two of them have noted on their applications that they are constructing treatment facilities. Six have what might be classified as primary treatment and one of these is constructing a secondary plant according to their application. Only three have what might be labeled secondary treatment.

The applications that we have received, the 39 that are on hand, vary greatly in completeness. Two were received in the last day or so and are not included in this survey at all. Twelve of them are minus Part B of the application, which includes data on roughly 60 major pollutant parameters. Fourteen remaining ones are minus some important data in these areas and this leaves only 11 that are complete enough that we are proceeding to analyze for the permit program.

We have data, then, on 37 dischargers, 12 of which you have to remember have absolutely no data on the major part of their pollutant parameters. I have here a series of tables, Mr. Chairman, that I would like to have introduced into the record and given to the conferees.

MR. WHITE: Fine. They will be accepted into the record as if read.

(The above-mentioned tables follow:)

## MIDDLE SAVANNAH RIVER AREA
## ESTIMATED POTENTIAL INDUSTRIAL WASTE LOAD REDUCTIONS

POUNDS PER DAY DISCHARGED
POTENTIAL REDUCTION

| | Georgia | South Carolina | Total | Net Remaining | |
|---|---|---|---|---|---|
| Ammonia | 4,500 | 7,100 | 11,600 | 2,800 | 80% |
| $BOD_5$ | 13,100 | 17,900 | 32,000 | 12,100 | 73 |
| Chromium | - | 630 | 630 | 90 | 87 |
| Chloride | - | 0 | 0 | 5,400 | 0 |
| Lead | 15 | - | 15 | 5 | 75 |
| Mercury | 1.1 | - | 1.1 | .3 | 73 |
| Total Kjeld. Nitrogen | 5,000 | 900 | 5,900 | 3,500 | 62 |
| Oil & Grease | 3,700 | - | 4,300 | 2,000 | 68 |
| Phenol | 0 | - | 0 | 1,850 | 0 |
| Phosphorous | 0 | 800 | 800 | 720 | 53 |
| Sulfate | - | 0 | 0 | 2,000 | 0 |
| Surfactants | - | 110 | 110 | 20 | 85 |
| Total Suspended Solids | 12,100 | 21,800 | 33,900 | 12,000 | 74 |
| Zinc | 100 | 0 | 100 | 90 | 53 |

NUMBER OF DISCHARGERS

| | Georgia | South Carolina | Total | Net Remaining |
|---|---|---|---|---|
| High pH | 6 | 6 | 12 | 0 |
| Low pH | 0 | 1 | 1 | 0 |
| High Temperature | 2 | 4 | 6 | 0 |

NOTES: (1) All numbers are rounded off to the nearest 100 lbs. or if less than 1000 lbs. to two significant figures.

(2) All data taken from Refuse Act permit applications received by Atlanta Office of EPA.

(3) Dashes indicate either none or insignificant amounts reported.

# MIDDLE SAVANNAH RIVER AREA
# LIST OF INDUSTRIAL DISCHARGERS

## Major [redacted] DISCHARGERS

### South Carolina

Barnwell Woolen Mills
Graniteville (Sibley)
Graniteville (Gregg)
J.P. Stevens (Allendale)
Kimberly Clark (Beech Is.)

### Georgia

Columbia Nitrogen
Continental Can
Olin

## Critical Industries

### South Carolina

Allied Gulf Nuclear Services
Graniteville (Indus. Waste Treat.)
Graniteville (Gregg Water Plant)
Graniteville Co (Water Treat. Plt.)
Graniteville Co (Woodhead Div.)
Graniteville Co (Hickman)
Graniteville Co (Stevens Steam)
Graniteville Co (Townsend)
Graniteville Co (Swift)
Graniteville(Sewerage Treat. Plt.)
Graniteville Co (Warren)
Graniteville Co (Granite Div.)
Graniteville Co (Vaucluse)
S. C. Elec. & Gas (Urquhart Sta.)
United Merchants (Clearwater Fin.)
United Merchants (Seminole Mill)
United Merchants (Langley Engraving Co.)
United Merchants (Bath Mill)
United Merchants (Valchem Div.)
USAEC Savannah River

### Georgia

Babcock and Wilcox (Hephzigah)
Babcock and Wilcox (Augusta)
Burris Phoenix Div. (Augusta)
Cities Service (Augusta)
Enterprise Aluminum Co
Du Pont De Nemours (Augusta)
Graniteville (Sutherland)
Graniteville (Enterprise)
Monsanto (Augusta)
Nipro Inc.
Philad Quartz (Augusta Plt)
Proctor and Gamble Mfg Co.
SC Electric and Gas (Martinez)
So Wood Piedmont (Augusta)
Superior Stone Co (Martinez)

## MIDDLE SAVANNAH RIVER AREA
## CURRENT INDUSTRIAL WASTE TREATMENT FACILITIES

| | GEORGIA | SOUTH CAROLINA |
|---|---|---|
| 1. No Treatment | Babcock & Wilcox (Augusta) | Graniteville (Water Tr. Plt) |
| | Babcock & Wilcox (Hephzigah) | Graniteville (Granite) |
| | Burris Phoenix Div | Graniteville (Gregg) |
| | Columbia Nitrogen | Graniteville (Gregg Water Plt) |
| | Graniteville (Enterprise) | Graniteville (Hickman) |
| | Graniteville (Southerland) | Graniteville (Sibley) |
| | Monsanto (Augusta) | Graniteville (Stevens Steam) |
| | *Nipro Inc. | Graniteville (Swint) |
| | *Olin Corp | Graniteville (Townsend) |
| | Philadelphia Quartz | Graniteville (Vauclose) |
| | S.C. Electric & Gas(Martinez) | Graniteville (Warren) |
| | Southern Wood Piedmont | Graniteville (Woodhead) |
| | | S. C. Electric & Gas (Urquhart) |
| | | United Merchants (Bath Mill) |
| | | United Merchants (Clearwater) |
| | | United Merchants (Langley Engr |
| | | United Merchants (Seminole) |
| | | United Merchants (Valchem) |
| 2. Primary Treatment | Dupont | Allied Gulf Nuclear Svcs |
| | Superior Stone | *Barnwell Woolen Mills |
| | | Graniteville (Ind Waste Tr Plt) |
| | | Kimberly Clark |
| 3. Secondary Treatment | Continental Can | Graniteville (Sewage Tr Plt) |
| | Cities Service | |
| 4. Treatment Unknown | Enterprise Aluminum | J. P. Stevens (Allendale) |
| | Procter & Gamble | USAEC |

* New or additional facilities under construction.

## MIDDLE SAVANNAH RIVER AREA
## INDUSTRIAL POLLUTION LOAD

| | POUNDS PER DAY DISCHARGED | | |
|---|---|---|---|
| | Georgia | South Carolina | Total |
| Ammonia | 5,000 | 9,400 | 14,400 |
| $BOD_5$ | 22,700 | 21,400 | 44,100 |
| Chromium | - | 720 | 720 |
| Chloride | - | 5,400 | 5,400 |
| Lead | 20 | - | 20 |
| Mercury | 1.4 | - | 1.4 |
| Total Kjeld. Nitrogen | 8,100 | 1,300 | 9,400 |
| Oil & Grease | 6,300 | - | 6,300 |
| Phenol | 1,850 | - | 1,850 |
| Phosphorous | 220 | 1,300 | 1,520 |
| Sulfate | - | 2,000 | 2,000 |
| Surfactants | - | 130 | 130 |
| Total Suspended Solids | 19,800 | 26,100 | 45,900 |
| Zinc | 160 | 30 | 190 |
| | NUMBER OF DISCHARGERS | | |
| High pH | 6 | 6 | 12 |
| Low pH | 0 | 1 | 1 |
| High Temperature | 2 | 4 | 6 |

NOTES: (1) All numbers are rounded off to the nearest 100 lbs. or if less than 1000 lbs. to two significant figures.

(2) All data taken from Refuse Act permit applications received by Atlanta Office of EPA.

(3) Dashes indicate either none or insignificant amounts reported.

MIDDLE SAVANNAH RIVER
SOUTH CAROLINA INDUSTRIAL DISCHARGE PROFILE
DATA OBTAINED FROM PERMIT APPLICATIONS ON 3/8/72

| | Flow (MGD) | pH Avg. | pH Max. | Summer Temp. Avg. | Summer Temp. Max. | $BOD_5$ Avg. #/Day | T.S. Avg. #/Day | $NH_4$ Avg. #/Day | TKN Avg. #/Day |
|---|---|---|---|---|---|---|---|---|---|
| C29 Graniteville - Warren | 0.036 | 7.8 | - | 78 | - | 20.9 | 329 | 2.76 | 0.167 |
| C27 Graniteville - STP | 0.5 | 7.2 | - | 79 | - | 41 | 788 | 49 | 68 |
| TOTAL In Kelley Creek | 0.536 | - | - | 79 | | 61.9 | 1,117 | 51.76 | 68.167 |
| C45 Un. Mer. Mfg. - Clearwater Finishing | 4.80 | 11.0 | 12.1 | 76 | 90 | 18,000 | 44,000 | 56 | 84 |
| C47 Un. Mer. Mfg.-Seminole | 0.14 | 6.6 | 9.9 | 104 | 111 | 236 | 619 | 12.25 | 0.40 |
| TOTAL In Little Horse Creek | 4.87 | | | | | 18,236 | 44,619 | 68.25 | 84.4 |
| C46 Un. Mer. Mfg.-Lang. Engraving | 0.003 | 2.5 | 2.5 | 83 | - | 0.8 | 26 | 0 | .024 |
| C48 Un. Mer. Mfg.-Bath Mill | 0.180 | 10.7 | 11.2 | 100 | 117 | 683 | 2,975 | 0 | 0.45 |
| C49 Un. Mer. Mfg.-Valchem | 2.5 | 9.6 | 10.4 | 79 | 83 | 1,538 | 12,580 | 8,395 | 1,105 |
| C16 Graniteville - WTP | 0.039 | 7.5 | - | 72 | - | 6.5 | 220 | 0.048 | 0.09 |
| C24 Graniteville - Vancluse | 0.010 | 7.4 | - | 77 | - | 1.2 | 5.1 | 0.128 | 0.083 |
| C21 Graniteville - Hickman | 0.039 | 6.5 | - | 80 | - | 22.9 | 47.0 | 0.17 | 0.464 |
| C12 Graniteville - Ind. Waste Treat. | 6.5 | 12.5(Intake) | | 110(Intake) | | - | - | - | - |
| C14 Graniteville - Gregg Div. | 0.1195 | 11.5(Approx) | | 85(Approx) | | 140.8 | 5,637 | 0.598 | 4.466 |
| C30 Graniteville - Granite Div. | 0.033 | 6.4(Approx) | | 63(Approx) | | 1.70 | 256 | 0.239 | 3.42 |
| C20 Graniteville - Woodhead Div. | 0.055 | 8.4 | - | 78 | - | 44.5 | 57.2 | 0.548 | 0.125 |
| C22 Graniteville - Stevens Steam | 0.010 | 6.9(Approx) | | 82 | - | 0.776 | 20.17 | 0.0246 | 0.506 |
| C25 Graniteville - Townsend | 0.029 | 6.5 | - | 76 | - | 4.78 | 12.9 | 0.13 | 0.13 |
| C26 Graniteville - Swint | 0.027 | 8.3 | - | 98 | - | 54 | 430 | 0.19 | 0.74 |
| 015 Graniteville - Water Treat. Plt. | 1.98 | 7.9 | - | 75 | - | 656 | 230 | 10.5 | 9.18 |
| TOTAL In Horse Creek | 12.60 | | | | | 3,217 | 22,613 | 8,459.4 | 1,192.8 |
| TOTAL In Horse Creek & Little Horse Cr. | 16.93 | - | - | - | - | 21,453 | 67,232 | 8,527.6 | 1,277.2 |
| 186 Kimberly Clark - Beech Island | 5.14 | 6.8 | 7.9 | 82 | 90 | - | 42,900 | - | - |
| 180 S.C. Elec. & Gas - Urguhart Sta. | 189 | 6.2 | 6.6 | 83 | - | - | 122,100 | 830 | - |
| TOTAL In Savannah River | 194.14 | - | - | - | - | - | 165,000 | 830 | 0.0 |
| TOTAL In Savannah River & Tributaries | 211.07 | - | - | - | - | 21,453 | 232,232 | 9,357.6 | 1,277.2 |

MIDDLE SAVANNAH RIVER
SOUTH CAROLINA INDUSTRIAL DISCHARGE PROFILE
DATA OBTAINED FROM PERMIT APPLICATIONS ON 3/8/72

| | T. Phos. Avg. #/Day | Sulfate Avg. #/Day | Sulfide Avg. #/Day | Surfact. Avg. #/Day | Phenol Avg. #/Day | Nitrite Avg. #/Day | Chromium Avg. #/Day | Chloride Avg. #/Day |
|---|---|---|---|---|---|---|---|---|
| C29 Graniteville - Warren | 1.19 | - | - | - | - | - | - | - |
| C27 Graniteville - STP | 18 | - | - | - | - | - | - | - |
| TOTAL In Kelley Creek | 19.19 | - | - | - | - | - | - | - |
| C45 Un. Mer. Mfg. - Clearwater Finishing | 141 | 360 | 0.0 | 60.1 | 0.0405 | 1.04 | 16.02 | 596.7 |
| C47 Un. Mer. Mfg.-Seminole | 23.25 | 13.13 | 0.0 | 0.89 | 0.0009 | 0.017 | 0.0005 | 4.6 |
| TOTAL In Little Horse Creek | 164.25 | 373.13 | 0.0 | 60.99 | 0.0414 | 1.057 | 16.02 | 601.3 |
| C46 Un. Mer. Mfg.-Lang. Engraving | 0 | 0.057 | 0.0 | - | - | 0.0 | 0.009 | 0 |
| C48 Un. Mer. Mfg.-Bath Mill | 84 | 102 | 0.14 | 19.5 | 0.0001 | 0.057 | 0.0006 | 11.1 |
| C49 Un. Mer. Mfg.-Valchem | 459 | 132.5 | 2.0 | - | 0.02 | 4.872 | 0.0008 | 198.2 |
| C16 Graniteville - WTP | 1.16 | - | - | - | - | - | - | - |
| C24 Graniteville - Vancluse | 1.014 | 0.344 | 0.014 | 0.072 | 0.0081 | 0.0 | 0.0014 | 0.595 |
| C21 Graniteville - Hickman | 1.59 | 3.056 | 0.376 | 0.0166 | 0.0030 | 0.0 | 0.0194 | 0.712 |
| C12 Graniteville - Ind. Waste Treat. | - | 1,348. | 48.5 | 48. | 1.51 | 0.0 | 701 | 4,531 |
| C14 Graniteville - Gregg Div. | 1.295 | 0.778 | 0.341 | 1.675 | 0.0032 | 0.002 | 0.395 | 26.98 |
| C30 Graniteville - Granite Div. | 123 | 0.524 | 0.035 | 0.014 | 0.0008 | 0.0036 | 0.219 | 1.862 |
| C20 Graniteville - Woodhead Div. | 0.457 | 0.943 | 0.541 | 0.016 | 0.011 | 0.0 | 0.034 | 2.98 |
| C22 Graniteville - Stevens Steam | 0.1379 | 0.967 | 0.0374 | 0.0017 | 0.0001 | 0.0 | 0.0001 | 1.314 |
| C25 Graniteville - Townsend | 0.0 | - | - | - | - | - | - | - |
| C26 Graniteville - Swint | 1.2 | - | - | - | - | - | - | - |
| C15 Graniteville - Water Treat. Plt. | 410 | 16.4 | 3.28 | 0.328 | 0.0 | 0.0 | 0.328 | 20.7 |
| TOTAL In Horse Creek | 1,102 | 1,605.6 | 53.12 | 69.5 | 1.5576 | 4.9346 | 701.78 | 4,735.3 |
| TOTAL In Horse Creek & Little Horse Cr. | 1,266.3 | 1,978.7 | 53.12 | 130.5 | 1.5976 | 5.9916 | 717.98 | 5,396.7 |
| 186 Kimberly Clark - Beech Island | - | - | - | - | - | - | - | - |
| 190 S.C. Elec. & Gas - Urguhart Sta. | 80 | - | - | - | - | - | - | - |
| TOTAL In Savannah River | 80 | - | - | - | - | - | - | - |
| TOTAL In Savannah River & Tributaries | 1,346.3 | 1,978.7 | 53.12 | 130.5 | 1.5976 | 5.9916 | 717.98 | 5,396.7 |

MIDDLE SAVANNAH RIVER
GEORGIA INDUSTRIAL DISCHARGE PROFILE
DATA OBTAINED FROM PERMIT APPLICATIONS ON 3/8/72

| | DISCH. FLOW RATE MGD | pH | | SUMMER TEMP °F | | BOD #/DAY | TOTAL SUSP. SOLIDS #/DAY | AMMON.A AS N #/DAY | TKN #/DAY | PHOS. #/DAY | FECAL COLIFORM BACTERIA NO/100 ML | LEAD #/DAY | MERC. #/DAY | ZINC #/DAY | OIL & GREASE #/DAY | PHENOL #/DAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LOW | HIGH | MIN | MAX | | | | | | | | | | | |
| Nipro, Inc. N-061 | 0.425 | 7.5 | 9.9 | 80 | 104 | 6,330 | 190 | 990 | 1200 | 1.4 | A | 0.4 | Nil | Nil | 25 | 1812.5 |
| Columbia Nitrogen N-044 | 1.05 | 7.5 | 9.1 | 86 | 99 | 620 | 620 | 3,760 | 4385 | 5.0 | 2,200 | 2.0 | Nil | 0.1 | - | - |
| Olin Chemical N-166 | 2.292 | 6.5 | 11.1 | 86 | 104 | 37 | 803 | 1 | 3 | 2.0 | 0 | 0.78 | 0.08 | 0.62 | - | - |
| Continental Can N-206 | 38.50 | 6.1 | 8.8 | 70 | 87 | 15,680 | 6,280 | 274 | 2542 | 197 | 190,000 | 0.28 | 1.25 | 157.0 | 5250 | 39.7 |
| Monsanto N-062 | 0.03 | 3.2 | 9.4 | 69 | 106 | 1 | 3 | 1 | 1 | 9 | 600,000 | 19.8 | 0.1 | 0.1 | 0.6 | 0.1 |
| Superior Stone N-225 | 0.025 | 7.0 | 7.0 | 76 | 76 | 2 | 11,480 | 1 | Nil | 0.06 | - | 0.1 | | | | |
| S.C. Elec & Gas Martinez, Ga. N-181 | 0.039 | 6.1 | 6.6 | 64 | 80 | Nil | 2 | Nil | 1 | 0.01 | - | | | | | |
| Dupont Co. N-281 | 0.012 | 6.0 | 11.0 | 84 | 85 | - | 157 | Nil | Nil | 3.8 | - | | | 0.41 | | |
| Cities Serv N-228 | 0.003 | 7.0 | 7.0 | 65 | 124 | N.C. | N.C. | N.C. | N.C. | N.C. | - | | | | | |
| Burris Phoenix N-120 | 0.521 | 6.5 | 13.0 | 80 | 100 | 20 | 50 | Nil | Nil | 0.29 | - | | | | | |
| Babcock & Wilcox N-119 | 0.810 | 5.2 | 6.5 | 74 | 90 | 13 | 13. | 2 | Nil | 0.05 | - | | | | 896 | Nil |
| Babcock & Wilcox Hephzibah N-118 | 0.026 | 6.3 | - | 74 | - | Nil | 166 | Nil | Nil | 0.04 | - | .09 | Nil | 0.05 | 42 | - |
| So. Wood Piedmont | 0.001 | 6.4 | - | 68 | 95 | 135 | 20 | Nil | 1 | 0.3 | - | | | | | |
| Philadelphia Quartz | 0.0001 | 7.0 | 11 | 100 | 200 | Nil | 1 | Nil | Nil | 0.01 | - | Nil | Nil | Nil | | 0 |
| Graniteville, Sutherland | 0.0029 | 6.3 | 7.3 | 67 | 72 | 1 | 1 | Nil | Nil | .05 | - | | | | | 0 |
| TOTAL | 43.737 | | | | | 22,839 | 19,794 | 5030 | 8132 | 212.81 | | 23.45 | 1.44 | 158.28 | 6212.6 | 1851.9 |

BOD = 5 day Biochemical Oxygen Demand; TKN = Total Kjeldahl Nitrogen as Nitrogen;

Phos. = Total Phosphorous; Merc. = Mercury

## MIDDLE SAVANNAH RIVER AREA
## ESTIMATED POTENTIAL INDUSTRIAL WASTE LOAD REDUCTIONS

|  | POUNDS PER DAY DISCHARGED POTENTIAL REDUCTION |  |  |  |
|---|---|---|---|---|
|  | Georgia | South Carolina | Total | Net Remaining |
| Ammonia | 4,500 | 7,100 | 11,600 | 2,800 |
| $BOD_5$ | 13,100 | 17,900 | 32,000 | 12,100 |
| Chromium | - | 630 | 630 | 90 |
| Chloride | - | 0 | 0 | 5,400 |
| Lead | 15 | - | 15 | 5 |
| Mercury | 1.1 | - | 1.1 | .3 |
| Total Kjeld. Nitrogen | 5,000 | 900 | 5,900 | 3,500 |
| Oil & Grease | 3,700 | - | 4,300 | 2,000 |
| Phenol | 0 | - | 0 | 1,850 |
| Phosphorous | 0 | 800 | 800 | 720 |
| Sulfate | - | 0 | 0 | 2,000 |
| Surfactants | - | 110 | 110 | 20 |
| Total Suspended Solids | 12,100 | 21,800 | 33,900 | 12,000 |
| Zinc | 100 | 0 | 100 | 90 |
|  |  | NUMBER OF DISCHARGERS |  |  |
| High pH | 6 | 6 | 12 | 0 |
| Low pH | 0 | 1 | 1 | 0 |
| High Temperature | 2 | 4 | 6 | 0 |

NOTES: (1) All numbers are rounded off to the nearest 100 lbs. or if less than 1000 lbs. to two significant figures.

(2) All data taken from Refuse Act permit applications received by Atlanta Office of EPA.

(3) Dashes indicate either none or insignificant amounts reported.

MR. CLOWARD: The first table--yes, sir? Excuse me.

MR. WHITE: Go ahead. I was just going to ask you to comment on them, but I see you are planning to.

MR. CLOWARD: Yes. The first of these tables is a list of the dischargers that we know about through the permit program.

The second is a list that summarizes--and this is based entirely on the data shown on the application--the status of treatment for each of them.

The third table, which I would like to go into in a little more detail, is a summary of the pollution loads as, again, shown by the applicants on their discharge. I have this divided into both Georgia and South Carolina portions as well as a total. The total of the applications--and you have to remember that,again, there are a number of these that are incomplete. They are as accurate as the data that the firms have gathered. Many of them have used just one grab sample to arrive at these numbers.

It basically shows 5,000 pounds of ammonia from Georgia, 9,400 pounds of ammonia from South Carolina, most of which is coming from the Horse Creek area, for a total of 14,400.

Five-day BOD: 22,700 from Georgia; 21,400 from South

Carolina, most of it from the Horse Creek area. There is 44,100 pounds of total BOD shown on the applications.

Chromium: There was no significant amount of chromium in the Georgia side; 720 pounds a day from South Carolina. Again this was mostly coming from the Horse Creek area.

Lead: The application showed roughly 20 pounds of lead from the Georgia side; none from South Carolina.

Mercury: There was 1.4 pounds total shown from the Georgia side; none from South Carolina.

Kjeldahl nitrogen: 810 pounds from Georgia; 1,300 pounds from South Carolina; for a total of 9,400 pounds.

Oil and grease: 6,300 pounds from the Georgia side; none from the South Carolina side or none appreciable.

Phenols: Here the number is 1,850, but I would caution you that most of this comes from one pulp mill and unfortunately the phenol test picks up a lot of other materials which are not true phenols, so that I would highly question this number, but it does show a total of 1,850 so-called pounds of phenols. None appreciable from the South Carolina side.

Phosphorus: 220 pounds from the Georgia side; 1,300 from the South Carolina side, most of which comes from the Horse Creek area.

Sulfate: None appreciable from the Georgia side; 2,000 pounds a day from the South Carolina side, again most of it from Horse Creek.

Surfactants: None appreciable from the Georgia side; 130 pounds from the South Carolina side.

Total suspended solids shows: 19,800 pounds from the Georgia side; 26,100 pounds from the South Carolina side; for a total of 45,900. The solids come mainly in the Savannah River, not from Horse Creek.

Zinc: 160 pounds from the Georgia side; 30 pounds from the South Carolina side, again coming mostly from Horse Creek; for a total of 190.

Two other areas of potential concern are pH. Both States have an acceptable range of 6 to 8-1/2 in their streams. There are six dischargers in each State whose pH is above that range and one in South Carolina whose pH is below that range.

High temperature, and by this we set anything above 100 degrees, there are two in Georgia, four in South Carolina.

I also have and will give to the conferees tables giving the more detailed data on each of the States.

In addition I will provide to the conferees tables which give an idea of what we think, based on the sketchy information, and I would like to emphasize that word "sketchy" information, that is available so far, what potential we think there is for reducing the waste loads.

That concludes my statement, Mr. Chairman. I will give the conferees copies of this.

MR. WHITE: Thank you. I missed most of it, Mr. Cloward, I am sorry. I had to go take a telephone call.

Comments or questions?

Mr. Howard?

MR. HOWARD: I will ask Mr. Cloward to comment about the temperature, for one thing.

Do those temperature data involve applications that are sent in from the industries?

MR. CLOWARD: Yes, sir, everything I have summarized.

MR. HOWARD: The effluent, in other words?

MR. CLOWARD: Yes, sir, that is correct. What I am trying to do, it is sketchy, not all of them are in, not all of them are complete, but just trying to give the conferees a picture of what these applications say.

MR. WHITE: Mr. Traina.

MR. TRAINA: Mr. Cloward, I notice that with regard to mercury you talk about 1.4 pounds.

MR. CLOWARD: Yes, sir.

MR. TRAINA: As I understand it, that has been knocked down to less than a quarter of a pound.

MR. CLOWARD: Most of that mercury shows up in one source, a pulp mill. And the question is, is the analysis accurate? And if it is accurate, what is it particularly coming from? Is it coming from the wood? They have no chlorine mercury cell operation.

MR. TRAINA: They don't have a mercury cell, so it would have to be coming from some product they bring into the plant?

MR. CLOWARD: Yes.

MR. TRAINA: And they report that much mercury in their effluent?

MR. CLOWARD: They report about 1.--I will have to check it to give you the accurate number.

MR. HOWARD: I think we ought to make the point that these data aren't confirmed by EPA or the State.

MR. WHITE: I was just going to--

MR. CLOWARD: Yes.

MR. WHITE: Excuse me, Mr. Cloward. I was going to make that point. And also in all probability we will have to check this one out because this could be a critical--

MR. CLOWARD: One and a quarter pounds is the amount from that one particular--

MR. LEDBETTER: That they reported in.

MR. TRAINA: I think we did. That is the reason I brought it up. I think if in fact we do have that much mercury coming into the river, we need to check that out.

MR. HOWARD: Actually the only discharge of mercury that we have our fingers on is with one plant and they have been averaging something like 0.1 or less.

MR. TRAINA: That is right, that is why I was surprised.

MR. HOWARD: And they have continued to close up their system, so I think we ought to qualify that, that these are data that were submitted to the Corps under this confusing trash act thing of 1899.

MR. WHITE: Let me ask you, Mr. Cloward, do you happen to know offhand--and I am sure the company representative will be here and address this later--do you know the source of their water?

MR. CLOWARD: I did not analyze that particular application. One of the fellows in our section did and I don't know the source of their water. But I would judge it is probably from the river, but I don't know for sure.

MR. LEDBETTER: Yes, the Savannah River.

MR. WHITE: O. K.

MR. CLOWARD: They do use an awful lot of it and I don't think they get it from the ground.

MR. TRAINA: Offhand, do you recall the source of the zinc discharge that is reported here? That again seems somewhat high. Report 190 pounds totally.

MR. CLOWARD: Yes. It comes from several firms and it is primarily in the Horse Creek Valley area.

It is coming primarily from--I am sorry, on the Georgia side. It is coming primarily again from the same source as the mercury. They reported that much on their application.

In the South Carolina side it is coming from several small places.

MR. TRAINA: Apparently that is a relatively minor amount on the South Carolina side?

MR. CLOWARD: Yes.

MR. TRAINA: Georgia is the larger side?

MR. CLOWARD: Yes.

MR. TRAINA: You say that is coming from--

MR. CLOWARD: It is coming from one of the textile firms on there, just one plant reported zinc.

MR. TRAINA: South Carolina?

MR. CLOWARD: South Carolina.

MR. TRAINA: On the Georgia side it is coming from the paper operations?

MR. CLOWARD: Pulp paper mill.

MR. WHITE: I have just been informed that when the Georgia technical presentation is made that this will be addressed.

MR. HOWARD: In the meantime do you want to make a comment about that?

MR. LEDBETTER: Yes. I think there are too many folks that filled out these application forms that have got a lot of gray hair or no hair and they are so accustomed to dealing in parts per million they forgot that they were supposed to report in parts per billion on a lot of these things. And consequently, it shows up as a lot higher poundage on a lot of these forms. But that is a problem they are creating for themselves. They had better read the fine print.

MR. CLOWARD: I would like to add that that is quite true. I haven't seen any instances in this particular case of that myself personally.

MR. WHITE: Mr. Tinsley, do you have any comment?

MR. TINSLEY: I have only one question. Of all of this data that has been reported through the permit program, how much of it is estimated as opposed to actual observed values?

MR. CLOWARD: I don't have a real knowledge of that, Ken. I can't answer it.

MR. TINSLEY: My only concern with this type information is that you have to be extremely cautious as to what you do with it and how you interpret it, and I would just simply like to make that statement, that I would definitely want to check specifically everything before any comments were made one way or the other with respect to that data.

MR. WHITE: Well, this represents the best data available, as I understand it, and admittedly it hasn't been confirmed, as Mr. Cloward indicated. I think it will be helpful to the conferees in developing conclusions and recommendations, but as you point out, Mr. Tinsley, I am sure that we are going to have to verify this before we make any specific or take any specific actions with respect to it.

Are there any other comments or questions?

Thank you, Mr. Cloward.

MR.TRAINA: I would like to now call on Colonel Howard Strohecker, District Engineer, Savannah District.

Colonel.

## COLONEL HOWARD L. STROHECKER
## DISTRICT ENGINEER, SAVANNAH DISTRICT
## U. S. ARMY CORPS OF ENGINEERS
## SAVANNAH, GEORGIA

COL. STROHECKER: Mr. White and other distinguished gentlemen, I am Col. Howard L. Strohecker, District Engineer, U. S. Army Engineer District, Savannah. I am also representing the South Atlantic Division, U.S. Army Corps of Engineers, at this conference. South Atlantic Division is my next higher headquarters stationed in Atlanta.

The Corps of Engineers interest in this conference is twofold. One involves studies, design and construction of Civil Works Projects, and the other is our regulatory responsibility in navigable waters of the United States. In the first instance, I would like to cover the Civil Works Projects of the Savannah River Basin in this area of concern and some subsidiary areas.

The Corps operates the new Savannah Bluff Lock and Pool, which is located approximately 13 miles below Augusta. The lock and pool is part of the Savannah River below Augusta navigation project, which is an open river improvement providing a channel depth of 9 feet and a width of 90 feet. This project extends from the upper part of the Savannah Harbor to

Mile 202.6 in the vicinity of Augusta, Georgia, and South Carolina.

The Clark Hill Lake is a multipurpose project located approximately 22 miles above Augusta, Georgia, outside of the area of concern of this project, but the discharge from Clark Hill, of course, enters the basin under consideration.

The Hartwell Lake Project is a multipurpose project located approximately 89 miles upstream from Augusta, Georgia, with the same reservations.

The proposed and authorized Trotters Shoals Lake is located--it is a multipurpose project. The proposed project will be located approximately 51 miles above Augusta.

The Corps of Engineers as an agency is charged with responsibilities of water resource planning and operation for Civil Works Projects. With the enactment of new laws and the emphasis on environmental quality, our water resource planning has taken a much broader spectrum of consideration. The Corps of Engineers, along with other Federal Agencies, are involved in the total concept of water resource management to include consideration of marine and freshwater fish, public recreation, water quality, pollution abatement, flood plain management, and most lately total environmental analyses.

Water quality investigations at Clark Hill and Hartwell

Lakes. The Savannah District conducts water quality investigations in conjunction with the Southeast Water Laboratory of the Environmental Protection Agency and the Georgia Water Quality Control Board in Savannah Harbor and in the entire Savannah Basin and also in the lower Altamaha River Basin. Specifically our activities in the area affected by this conference include the water quality investigations at Clark Hill and Hartwell projects on a monthly basis during the spring, summer and fall months to establish the trends of these impoundments on water quality and to develop criteria for predicting the effects of other impoundments on water quality.

Water quality equipment at Clark Hill and Hartwell Lakes. We have installed water quality monitoring equipment downstream from the Clark Hill Dam for continuous measurement of four parameters: Water temperature, dissolved oxygen, pH and conductivity. Similar monitoring equipment is being installed downstream of Hartwell Lake. In addition, temperature monitors are distributed in the streams discharging into the reservoir and at locations below the dams.

Laboratory facilities. The South Atlantic Division is obtaining a mobile laboratory unit and an atomic absorption spectrometer for assisting the district within South Atlantic Division in water quality investigations, preimpoundment and postimpoundment surveys, water quality monitor maintenance, etc. The laboratory, when fully staffed, will give the South Atlantic Division a capability comparable to the Environmental Protection Agency. Water samples will be furnished the Division laboratory for analyses which the Districts do not have the equipment to perform.

Impoundment water quality control testing at Clark Hill and Hartwell Lakes. Turbine aeration tests have been performed at Hartwell and Clark Hill projects. The results of these tests look favorable and may be one possible solution for improving the water quality of impoundments and releases therefrom during periods of thermal stratification.

A preimpoundment survey will be made of the Trotter Shoals project.

The Corps of Engineers as an agency is charged with certain responsibilities for public welfare and we are, of course, interested in various aspects of water quality improvements and problems, specifically water pollution abatement. We are concerned primarily along the upper Savannah River with navigation features for the Savannah River below Augusta. As part of our responsibility, we try to maintain this waterway to its authorized depth and width. The minimum navigational releases at new Savannah Bluff Lock and Pool is 5,800 cfs. They attempt to maintain this year round. The minimum flow being maintained at the present time is 6,300 cfs. The increased release from 5,800 to 6,300 will be continued as long as sufficient surplus water is available to assure the minimum navigational release requirement and the dependable power capacity under contract at Hartwell and Clark Hill. We believe that 6,300 cubic feet per second will be available as much as 75 percent of the time during most years.

Now, the regulatory functions of the Corps of Engineers. The Rivers and Harbors Act of 1899--Mr. Howard's trash act of 1899--is the principal law for the protection and preservation of navigation in the navigable waters of the United States. This act is administered by the Corps of Engineers. The application of this law has often been tested in courts over the period of years and it has been broadened to include aspects of general public interest in addition to navigation, which was its principal focus at the time the act was passed. This has been further reinforced by enactment of legislation for the protection and preservation of the environment, some of our more recent acts. In the administration of this law, the Corps of Engineers is responsible for issuing permits to authorize work in navigable waters of the United States under Section 10 of the Act, this section governs construction, and under Section 13, which governs waste disposal or refuse.

In December 1970 the President issued Executive Order No. 11574 directing the Secretary of the Army to promulgate regulations and procedures for a permit program to be administered in conjunction with the Environmental Protection Agency. The findings of the Environmental Protection Agency in any Section 13 permit action in their determinations and interpretations of water quality standards will be accepted as determinant from the Federal viewpoint. Coordination with those Agencies involved in fish and wildlife and resource protection was also required in the implementation of the Section 13 of the Refuse Act of 1899.

The Corps of Engineers regulation which governs my actions with regard to this act requires that I give specific consideration and evaluation of any proposed discharge which an applicant submits an application for, evaluation of the proposed discharge on navigation, fish and wildlife, water quality, conservation, aesthetics, ecology, and other environmental factors. The Refuse Act permit program has been implemented by the Corps of Engineers as directed.

All outfalls or other structures in the navigable waters of the United States require a Department of the Army permit under Title 33, U. S. Code, Section 403, except as specifically provided in the Refuse Act under Title 33, U. S. Code, Section 407. All discharges or deposits of any kind or description whatsoever in navigable waters of the United State or their tributaries are unlawful in the absence of an appropriate Department of the Army permit. All firms--and I emphasize firms rather than municipalities, which are exempt under the provisions of the 1899 Act--all firms which were discharging into navigable waters or their tributaries without a permit were required to submit applications to the Corps of Engineers by 1 July 1971. Mr. Cloward has already covered much of the details of the implementation of this Act as it concerns the upper Savannah River Basin to date.

We have received as of today two applications from Federal facilities, Fort Gordon and the AEC, and 43 applications from firms discharging waste into Savannah River or its tributaries within the area from Stevens Creek to Johnson's Landing, the area under concern. And as I stated, Mr. Cloward has discussed much of the information that is contained in these 43 applications.

The applicants were required to furnish detailed chemical analyses of their discharge. All applications are currently being processed and this includes review by the

Environmental Protection Agency, the Department of the Interior, the National Oceanic and Atmospheric Administration, and the applicable State pollution control agencies. When the applications are considered administratively complete, public notices on the applications will be issued. None have been issued so far for any of the applications in this area under consideration at this conference.

A determination as to whether a permit will be issued will be based on the relevant factors which I indicated above. To date no permit has been issued for discharge to any of the applicants within the area under consideration. Refuse permit program is a powerful pollution control mechanism for the protection of the environment in regards to water quality. The Savannah District in carrying out its Civil Works and Regulatory responsibility has worked very closely with Federal, State, local governments, conservation groups, and the general public in the enhancement of our environment.

This completes my statement, Mr. White. I have given a copy to the steno and I have copies for the members of the conference here.

MR. WHITE: Thank you very much, Colonel.

MR. HOWARD: Thank you, Colonel.

MR. WHITE: You did touch on one thing that has been near and dear to the enforcement people in the Southeast in particular with respect to the turbine aeration project. Do you know when you might have any conclusions from this experiment?

COL. STROHECKER: We have conducted rather extensive tests within the South Atlantic Division at Lake Altamaha, and the turbine aeration method of increasing dissolved oxygen in releases, particularly during the period of thermal stratification in the summertime when the cold water sits on the bottom and the hot water is on the top, shows some promise. We have also investigated a method of putting air diffusers and pumping air under pressure at various locations in the impoundment. This also shows some promise.

Now, the complete study of aeration of impoundments behind large dams should be complete this spring and made available to all Federal Agencies that have an interest in this.

Now, as to when any mechanisms or remedial measures will be installed or changes in operation will be directed at our releases, this depends on congressional funding, as you are well aware.

MR. WHITE: Yes, I understand. But of course this could have application--

COL. STROHECKER: Right.

MR. WHITE: --over a wide range and with many private utilities also.

COL. STROHECKER: Right.

MR. WHITE: Comments or questions by any of the conferees?

MR. TINSLEY: Nothing here.

MR. WHITE: Mr. Howard?

MR. HOWARD: I would like to make a couple of comments and ask a question.

Colonel, first of all, I want to say for the record that we have enjoyed and benefited greatly from the cooperative programs that we have had with the Corps, especially Savannah District, on monitoring and surveillance.

The other thing I want to say is that I want to ask a question.

COL. STROHECKER: All right.

MR. HOWARD: You say you carried on some monitoring on Clark Hill and Hartwell. Do the releases from those two impoundments meet the existing water quality standards of the Federal Agencies and the State? That may not be a fair question, but--

COL. STROHECKER: Well, I will get you an answer. I do not have the answer to that, Mr. Howard.

MR. HOWARD: I just wondered if the dailies show that or not.

COL. STROHECKER: I don't know. I will have to check that. I do not have the answer to that question.

MR. HOWARD: The other question I would like to ask is for the benefit of our industries here today, for example, what is the current status of the 1899 permit system, you know? Are we doing anything or has it come to a standstill? And what should they do?

COL. STROHECKER: I think Mr. Cloward covered it pretty well. We believe that we have applications from all industrial dischargers in this area, some 43. We have not identified any that we know are discharging in violation of the Act. There may be some that will later come to our attention. So the applications are in.

As Mr. Cloward has indicated, in many cases they are incomplete and we have asked the industrial dischargers for additional information where we know they are incomplete. Those that we feel are complete or complete enough for partial processing we have forwarded to the regional office of the Environmental Protection Agency and that is as far as I can take it.

So we have moved them out of our office.

MR. HOWARD: I have had some difficulty in implementing some programs that we have developed over the years.

COL. STROHECKER: Right.

MR. HOWARD: And I would just like to know are we going to move out now and issue permits or are we just going to spin wheels again?

COL. STROHECKER: Well, I have to defer to Mr. Ravan and Mr. Traina on that.

MR. WHITE: I believe that--

MR. TRAINA: I will answer that.

MR. WHITE: Let me make one comment here. Of course the so-called Kalur decision has enjoined the Secretary of the Army from issuing any permits and that is under appeal. I don't believe there is anything recent on that, is there?

COL. STROHECKER: There is nothing recent on that, Mr. White. However, our instructions are to proceed as though that decision had not been reached up to the point of actually signing the permits and we are to carry this down to the last step, including holding public notices and issuing public notices, the works, everything except finally signing the permit.

MR. WHITE: Yes, I understand that, and I believe that this is the view that the Environmental Protection Agency has and I think things are being processed as rapidly as possible. I am not completely sure on that.

Mr. Traina.

MR. TRAINA: I would just like to add, business as usual pending this court decision. We are not slowing up in review, as you know.

MR. HOWARD: I would like to tell my industries business as usual too, go ahead with construction, but they are scared.

MR. TRAINA: Colonel, just one point.

In your statement you made reference to the AEC and the Fort Gordon installation. There is someone here from the AEC and I assume he will direct his comments to that situation.

However, I noticed there is no one here from Fort Gordon. Could you speak to the situation at Fort Gordon?

COL. STROHECKER: Essentially, Fort Gordon has a sewage treatment plant and they in domestic wastes as treated, and I think they were covered by Mr. Little in some detail, do not fall under the provisions of the 1899 Refuse Act. Now, any industrial type discharges, those that might come from washing vehicles or any industrial or semi-industrial type activities that are conducted at Fort Gordon, the discharge and the effluent of which would enter a storm sewer system, this is covered under the Refuse Act and we have received an application from the commanding general of Fort Gordon for a permit for this type of discharge. It is being processed exactly like the 43 industrial dischargers.

MR. TRAINA: Mr. Little reported apparently the municipal wastes, the sewage of the plant, is adequately handled?

COL. STROHECKER: Yes, that does not come under the Refuse Act.

MR. TRAINA: The industrial part does come under our processing.

COL. STROHECKER: That is correct.

MR. WHITE: Thank you very much, Colonel.

MR. TRAINA: I would like to next call on Mr. G. H. Giboney, who is the Director of the Office of Environmental Affairs, U. S. Atomic Energy Commission, Aiken, South Carolina. Mr. Giboney.

G. H. GIBONEY, DIRECTOR
OFFICE OF ENVIRONMENTAL AFFAIRS
SAVANNAH RIVER OPERATIONS OFFICE
U. S. ATOMIC ENERGY COMMISSION
AIKEN, SOUTH CAROLINA

MR. GIBONEY: On behalf of my management I would like to say that the Atomic Energy Commission is pleased to have the opportunity to participate in this conference today sponsored by the Environmental Protection Agency.

The AEC manager at the Savannah River plant, Mr. Nathaniel Stetson, has asked me to express the desire of the plant management to cooperate in every way with the EPA and other agencies to control pollution.

We are pleased to see that the draft report which dealt with pollution in the Savannah River issued by EPA included among its conclusions the fact that organic wastes and thermal discharges from the Savannah River plant caused no noticeable effect in water quality in the Savannah River.

On the subject of radioactive releases to the river, we are justifiably proud to report that they have been kept at an innocuous level during the 20 years we have been in operation. Measurements demonstrating this have been made continuously by our plant personnel and have been confirmed by independent measurements made by the U. S. Public Health Service and South Carolina and Georgia radiological experts.

With respect to the risk of thermal pollution, the Savannah River reactors are designed for the production of reactor products and not for generation of electricity. Consequently, the heat generated is totally waste heat. However, several miles of streams and a large swamp area permit the dissipation of almost all of this heat within the Savannah River Plant boundaries. Our average effect on the river is an increase of only about 1.1 degree Fahrenheit, well under South Carolina and Georgia standards. You may be interested to know that the cooling water effluent returned to the river is actually cleaner from the standpoint of bacterial content than when pumped from the river.

The Atomic Energy Commission has funds budgeted for fiscal year 1973 for the installation of secondary treatment for all sanitary wastes at the plant as required by Executive Order No. 11507.

That concludes the statement.

MR. WHITE: Thank you, sir.

Comments or questions?

Mr. Traina?

MR. TRAINA: Mr. Giboney, the report, while it does say that there is no effect on Savannah, does talk about some localized problems. I assume the last statement you made with regard to your facilities that are to be constructed will clean up your local problems on the plant site from the organic pollution?

MR. GIBONEY: From the standpoint of sanitary wastes and organic pollution, our installation should take care of those problems.

MR. TRAINA: The report recommends--excuse me, sir.

MR. GIBONEY: I started to add that observable changes in the on-site streams may relate to two things, additional water flow in those stream beds and some elevated temperature from cooling water discharge downstream.

Now you were raising a question.

MR. TRAINA: The report recommends that your plant should provide secondary treatment of domestic wastes by December 1972. Will you be able to meet that date, sir?

MR. GIBONEY: We will not expect to meet 1972 December deadline, but early 1973.

MR. TRAINA: Would you give us a date, feel comfortable giving us an approximate date, at least a month?

MR. GIBONEY: No.

MR. TRAINA: Would you say before June of 1973?

MR. GIBONEY: Before June should be reachable, yes.

MR. TRAINA: With regard to your thermal discharges--again we did confirm the fact that there is no elevation in the Savannah River--does AEC have any plans with regard to controlling thermal pollution on the plant site?

MR. GIBONEY: Not with respect to the operating reactors as they are now operating.

MR. WHITE: But--excuse me, go ahead, Mr. Giboney.

MR. GIBONEY: We have no plans for change.

MR. WHITE: But to get something straight, I understood you to say that your figures show that the Savannah is being elevated approximately 1 degree currently, is this correct?

MR. GIBONEY: Right.

MR. WHITE: Over what length of the stream is this occurring in?

MR. GIBONEY: I don't know whether I can address that. We measured upriver from the plant and down below our last discharge into the river and we assessed for ourselves the approximate elevation of river temperature by 1 degree.

MR. WHITE: Historically have you had any other results, I mean indicating a higher level of heat addition, that you are aware of?

MR. GIBONEY: We have seen at low flow and with the operation of more reactors than we now have a change in river temperature assessed to be at about 5 degrees.

MR. WHITE: That was with how many reactors?

MR. GIBONEY: Five reactors.

MR. WHITE: Five? I am sure you stated this, but I must have missed it. How many are in operation now, three?

MR. GIBONEY: Three. One of those, however, is in a closed loop circuit discharging and drawing water from an on-plant pond or lake, so that it has little effect on the river to basically affect the river at this point.

MR. WHITE: And you plan to operate those indefinitely?

MR. GIBONEY: We have no plans to change the cooling system.

MR. WHITE: Mr. Traina?

MR. TRAINA: No, I don't have anything else.

MR. WHITE: Mr. Tinsley, I would like to explore one thing and possibly you should address this.

Now, the streams on the site of the Savannah River plant, these have not been classified by South Carolina, as I understand it?

MR. TINSLEY: I can't speak for the specific streams, but if they have not been specifically classified they would assume the classification of the stream to which they are tributary. This means that they would assume the classification of the Savannah if they have not been specifically classified.

MR. WHITE: I see. And you have no personal knowledge or entry into anything concerning the quality aspects of that in addition to that that was in the report?

MR. TINSLEY: Let me look at the map here.

Those waters would be, based on just a cursory look, classified B, and according to the State standards the temperature could not exceed 90 degrees F. nor a rise in excess of 5 degrees.

MR. TRAINA: I believe that your temperatures do exceed that on plant site, do they not, sir?

MR. GIBONEY: Yes, they exceed that.

MR. TRAINA: Do you know what the average temperatures are?

MR. GIBONEY: I wouldn't care to comment, but we see 60 degrees C. along the streams, so under the present design of the reactors, without some change in cooling system, we could not comply with the 5-degree rise.

MR. WHITE: Does the public have access to the plant site, these streams?

MR. GIBONEY: No, these are totally on-site streams and I suppose could be approached upriver from--upstream from the river. But they reach--I guess they do not reach beyond the plant boundaries back into the public zone. Totally on-site streams into which we discharge thermal load.

MR. WHITE: Let me ask you this. These treatment facilities that you indicate that will be in operation in June of 1973, have you taken into account any of the water quality aspects in the design or are you providing simply secondary treatment in the general--

MR. GIBONEY: Adding only secondary treatment under this funded operation.

MR. WHITE: But I mean with no consideration as to the size and ability of the receiving waters to assimilate?

MR. GIBONEY: No.

MR. TRAINA: You will have disinfection with that facility, sir?

MR. GIBONEY: Right.

MR. WHITE: Are there other comments or questions? If not, thank you very much, Mr. Giboney.

MR. TRAINA: The next speaker I have listed here, Mr. Chairman, is Mr. James Westbrook, Sanitary Engineer with the Department of Health, Education, and Welfare in Atlanta.

J. A. Westbrook

JAMES A. WESTBROOK
SANITARY ENGINEER
REGIONAL ENVIRONMENTAL COORDINATOR
OFFICE OF THE REGIONAL DIRECTOR
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
ATLANTA, GEORGIA

MR. WESTBROOK: Mr. Chairman, members of the conference, ladies and gentlemen.

I am James A. Westbrook, Regional Environmental Coordinator in the Office of the Regional Director in the Department of HEW, Health, Education, and Welfare, in Atlanta, Georgia. I was asked by Dr. Groschelle, who is the Regional Director, to give a statement for him. This is a brief statement having to do with the Department of Health, Education, and Welfare's stand with respect to this meeting.

> The Department of Health, Education, and Welfare in its role as the official health Agency of the Federal Government is primarily concerned with the uses of the river as they relate to the health and safety of the public.
>
> In this regard, the area of the river used for drinking water should have maximum protection from pollutants to minimize the degree

of treatment necessary for potable and safe drinking water. As for the parts of the river used for fishing, boating, and other recreational pursuits, it is essential that every effort be made to preserve the quality of water in undeveloped areas, and to restore the quality of water in other areas to conditions that permit increased beneficial use.

The Department of Health, Education, and Welfare does provide technical assistance on environmental problems which may adversely affect man's health and safety.

Thank you.

MR. TRAINA: Thank you, Mr. Westbrook.

MR. WHITE: Any comments or questions?

Thank you, Mr. Westbrook.

MR. TRAINA: Mr. Chairman, there are a number of other Federal Agencies represented here. I don't have any indication that any of them would like to make a statement.

I might just ask those representatives, is there anyone here who would like to make a statement from a Federal Agency at this time?

If not, Mr. Chairman, that concludes the Federal presentation.

MR. WHITE: Thank you, Mr. Traina.

We went a little longer than we initially thought we would on the Federal presentation and we plan to now go into the Georgia presentation.

I understand from Mr. Howard that the Mayor of Augusta is here and we want to accommodate him. We would have taken a break now, but rather than do that we will proceed with Mr. Howard's presentation and will likely take a break after the next speaker.

MR. HOWARD: Mr. Chairman, in my usual gracious manner I deferred to the Feds, but had I known you were going to have so many folks come up to the lectern and all I would have had the Mayor of Augusta first.

Mr. Mayor, I am proud to have you here. Mayor Beckum is a member of the Georgia Water Quality Control Board and he has a statement he wants to make in behalf of the city of Augusta.

MILLARD A. BECKUM

MAYOR, CITY OF AUGUSTA

AUGUSTA, GEORGIA

MR. BECKUM: Thank you very much, Mr. Howard.

I am delighted to be here, Mr. Chairman, conferees, ladies and gentlemen, especially glad because I heard Mr. Asa Foster say that he had $100,000 that belonged to me (laughter) and it gave me the chance to amend his admission. I told him he had almost a quarter of a million dollars of my money tied up and we are going to hurry up and get some spades in the ground so we can get that money, we need it so badly for what we are trying to do.

I am delighted to have the opportunity of making on behalf of the citizens of Augusta the following statement:

On February 24, 1962, the City Council of Augusta instructed me, as Mayor, to make application for funds to provide for the construction of a primary wastewater treatment plant. Cooperation was sought from the Board of Commissioners of Roads and Revenues of Richmond County, a committee of which joined with me to visit Atlanta to make application before the appropriate representatives to obtain such Federal and State funds as we could to implement this project. We were able to get the appropriate amounts of money allocated. We spent

$3,125,544.31 on the building of the primary plant and got under way at the same time construction of the primary sewage treatment plant and other facilities which were contributory to it, such as the improvement of our sewage system.

The city made the primary wastewater treatment plant a part of a major sanitary sewage improvement program. The City Counselor of Augusta authorized the sale of $6 million in revenue certificates to finance this program, which was used in connection with Federal funds, of course, to meet all of the environmental requirements which were placed upon us at that time. Construction work on the plant began April 25, 1967. The plant was completed and put in operation March 26, 1969.

During the latter stage of construction, the Honorable George A. Sancken, who succeeded me as Mayor of Augusta in 1964, was notified that the city of Augusta would be required to treat wastewater effluent to a secondary level. Much planning on ways and means for funding this project were carried on by Mayor Sancken and members of the City Council. Preliminary plans were done by Zimmerman, Evans and Leopold.

On January 4, 1970, upon my return to office as Mayor, intensified efforts were made to develop another major sewer improvement program to eliminate discharge of raw sewage into the Savannah River. The secondary treatment facilities are part of this program. Zimmerman, Evans and Leopold were employed to make construction plans. Application for Federal funds was made through the Georgia Water Quality Control Board.

Construction plans have recently been approved. The City Council of Augusta has authorized the sale of $8 million in revenue certificates for the purpose of meeting all of the environmental conditions placed upon us by the appropriate agencies. This includes the Milledgeville Road and Garlington Avenue, Magnolia and Richmond Drive projects, which, incidentally, have been completed.

Construction is anticipated to begin on the second plant and the diversionary valve system to separate stormwater from sanitary sewerage and the cleaning of the canal system and dredging to increase the flow of water and to remove the problems which are with us today.

Augusta, Georgia, is an old city with many problems, but we are consistently and conscientiously striving to make improvements as will make ours a more pleasant and healthful city in which to live. As Mayor of Augusta, I would respectfully urge Federal authorities to move aggressively in the effort to provide greater financial assistance so that this city, like all cities of America, might be able to more realistically deal with the mammoth sewerage and wastewater treatment which is in such a condition of need that the cities such as mine and many others simply cannot finance the needs which are before us now. Legislation must be introduced to provide more money for the cities of this Nation to enable them to deal realistically with this major problem.

This concludes my statement. Thank you very much.

MR. HOWARD: Thank you, Mr. Mayor.

MR. WHITE: Thank you.

MR. HOWARD: Any questions, Paul?

MR. TRAINA: I would just like to comment that with regard to the Federal share, I think legislation that has passed the Senate and I understand just passed the House does include a significant increase in Federal participation, total monies and percentagewise also, sir.

MR. BECKUM: I have heard about it and I certainly hope nothing happens to it.

MR. TRAINA: So do we.

MR. BECKUM: And incidentally, tell Mr. Foster to send me that money because we are going to invest it in a sewer. (Laughter.)

MR. HOWARD: Thank you, Mr. Mayor.

Mr. Chairman, I think we ought to mention something here, that Mayor Beckum, while a member of the Georgia Water

Quality Control Board back in 1965, was one of the members that approved unanimously the rules requiring effluent standards and secondary treatment for the State of Georgia, so you see he imposed these requirements on his successor.

MR. BECKUM: I thought he would get it finished before I got back, but he didn't. (Laughter.)

MR. WHITE: Thank you very much, Mayor.

We stand recessed for 10 minutes.

(RECESS)

MR. WHITE: Let's go back in session, please.

During the break we decided that we would deviate slightly from the order of presentation that I outlined previously. Mr. Howard has graciously yielded the floor to South Carolina and I believe Mr. Tinsley has one or two people that he would like to call up at this time so they can make their presentation and get back to pressing business.

After that, we will go back to the Georgia technical presentation and then the presentation of anyone on the speakers' list who indicated that they wish to make a statement.

With that, would you please proceed, Mr. Tinsley.

MR. TINSLEY: Thank you, Mr. Chairman.

First I would like to call the Honorable H. O. Weeks, Mayor of the city of Aiken.

## H. O. WEEKS

MAYOR, CITY OF AIKEN

AIKEN, SOUTH CAROLINA

MR. WEEKS: Mr. Chairman, ladies and gentlemen.

It is a pleasure to be here today to represent the city of Aiken. I appreciate very much Mr. Howard's consideration here. He is a former classmate of mine in 1930. We just spoke a few minutes ago. I am surprised that he recognized me. He said that he was very surprised I turned out to be a politician and he a bureaucrat. (Laughter.) But you are doing a very good job.

On behalf of the city of Aiken I would like to read a very short statement.

The city of Aiken has on file an application with the Environmental Protection Agency for funds to expand the facility from one million gallons per day to a proposed three million gallons per day. This application has been on file since September 2, 1971.

It is proposed to convert the existing treatment plant to a high rate trickling filter plant followed by activated sludge with a capacity of 3 MGD average flow and 7.5 MGD peak flow, adequate for a population of 30,000 people and for BOD removals of 90 percent or more.

If it is economically feasible, the city of Aiken would be willing to participate in the centralized waste collection system and waste treatment facility for the entire Horse Creek Valley area provided the cost would be no more than for constructing and operating facilities now proposed for the city of Aiken.

I would like to add that the city of Aiken has had a secondary treatment plant since the year 1934 and I believe we have had about four expansions since that date.

Thank you.

MR. WHITE: Thank you very much, Mayor Weeks.

Comments or questions?

MR. TINSLEY: I don't have any questions myself.

MR. HOWARD: Yes, I would like to comment.

MR. WHITE: I think Mr. Howard might want to comment to your statement about being classmates.

MR. HOWARD: Are you sure it was 1930? (Laughter.)

MR. WEEKS: I think so, Ralph.

MR. HOWARD: I am proud to say, you know, that Mayor Weeks, one of my classmates, shows that he has been concerned about water pollution for a long time. Most of our Clemson boys are. We don't have much of a football team, but we do have pollution fighters. (Laughter.)

MR. WEEKS: Thank you, sir.

MR. WHITE: I understand there is hope for you over there now, Rock, I am not sure. (Laughter.)

MR. HOWARD: Thank you, Mr. Mayor.

MR. WHITE: Mr. Tinsley.

MR. TINSLEY: Next I would like to call the Honorable R. W. Walters, Mayor of the city of North Augusta.

R. L. WALTERS
MAYOR, CITH OF NORTH AUGUSTA
NORTH AUGUSTA, SOUTH CAROLINA

MR. WALTERS: Mr. Chairman, members of the conference, I would like to express my appreciation, as the Mayor of North Augusta, for the opportunity to be here at this conference and to present to you gentlemen the steps which we have taken to stop the pollution of the Savannah River. I would like to assure you that we are as concerned as you are with what we are doing, and if you would allow me to digress just a minute I would like to go back to the time schedule that has occurred for some 2-1/2 years.

One of our problems, I think, in North Augusta, and this is maybe of no concern to you, but it is a contributing factor to the time schedule, is the fact that the governing body of the city of North Augusta operates on a 2-year term. I assumed office in May of 1971 and this thing immediately was put on my desk, and frankly I have been studying it ever since because there is a lot of digging that has to be done to understand exactly what did occur prior to my assuming office.

But the city of North Augusta was issued a permit by the State Health Department on January 11 of 1954 to discharge up to 8.8 MGD of mixed domestic and industrial waste into the Savannah River.

On November 3 of 1969, after considerable consultation with the pollution control people, the city of North Augusta made formal application to FWPCA for a grant to help fund a sewage treatment plant. This was on November 3 of 1969.

On February 24 of 1970 approval by FWPCA of our application was received by the city.

On September 2 of 1970 an offer was made from FWPCA to the city of North Augusta for a grant in the amount of $365,400. I point out to you gentlemen that it was 14 months after our application was made on November 3 of 1969 before an offer was made from FWPCA for a $365,400 grant.

Now, we were talking in the neighborhood of $1.75 million and the financing, frankly, as Mayor Beckum has said, is something that the city of North Augusta didn't have, we didn't know where it was coming from. We were told that we could make applications, which we did, to various Federal Agencies for help. This was the first acceptance of an application that we received, was September 23 of 1970.

On August 4 of 1970 we applied to HUD for assistance in financing. On August 10, six days later, HUD acknowledged our application, and on December 10 of 1970 they turned this application down, stating that there were no funds available for us. This was 4 months after our application to HUD.

I assumed office, as I told you, in May 1971, and just a few days, May 12, to be exact, after assuming office I received word from HUD that funds possibly could be available for our application in that year's fiscal program which ended in June and that if we would get an updated application in that the possibility existed that we could be assured of a loan, so we authorized our consulting engineers to immediately proceed to update our application, we personally took this to Atlanta and presented it to HUD on May 12, and on July 23 of 1971 we received the notice from HUD of approval of a $1 million loan for 30 years at 6 percent. This was on July 23, 1971.

In September we instituted a sewer charge. Now, we are talking about $1.75 million. The city of North Augusta has been assured of a loan of $1 million from HUD, 6 percent, which had to be repaid by the city. In addition we were required--not required, but it was necessary that we sell revenue bonds against a system of approximately a quarter of a million dollars. This was $1,250,000 that the city had to finance and it had to be repaid.

So we studied means of repayment and with our consulting engineers during the summer of 1971 we came up with a schedule and on September 1 of 1971 we inaugurated in the city a sewer charge, charging a fee to the citizens of North Augusta who were tied in to a sewer line that was discharging into the Savannah River. This was September 12 of 1971.

Now, on April 15 of 1970 the city was given a cease and desist order and given until April 15 of 1972 to have a sewage treatment plant in operation. There is no way, naturally, that we can meet that schedule. We have tried to come up with a schedule that we can live with. We have arranged the financing. We know that we can pay for it. Our experience from September 1st indicates that we can pay for it, although three times the Internal Revenue Department wrote us and called us and told us to stop our sewer charge because of the wage and price freeze. Each time we answered them with a copy of a letter where we had been given clearance on instituting this charge by the HUD people in Atlanta.

R. L. Walters

So we have had numerous things which have caused delay, but we are proceeding and to bring you up to date I would like to give you the schedule which we hope you gentlemen will adopt. It is something that we can live with. This is from our consulting engineering firm of Zimmerman, Evans and Leopold.

> It is the purpose of this letter to set forth a schedule for completion of plans and specifications for review and approval by State and Federal Agencies, and to project a reasonable timetable for bidding, contract letting and construction of the sewage treatment facilities.
>
> In light of recent developments and the increase in the project's scope and using presently established criteria of design, it is expected that the plans and specifications will be submitted for review not later than September 1, 1972. Assuming that the review would be completed by October 1, 1972, such that the project could be advertised October 15, the bid date would then be set for November 15, 1972. Contract negotiations and financial

arrangements normally require 30 to 45 days to complete and furnish executed documents to all parties concerned. With this schedule a notice to proceed could be issued on January 1, 1973.

With regard to construction time, we are of the opinion that 15 months will be required to construct a project of this nature. Thus, it may be expected that sewage treatment facilities for North Augusta will be completed and in operation by April 1, 1974. The above schedule is contingent upon locating the treatment facility at the presently planned site; approximately 1,000 feet downstream from the Thirteenth Street Bridge.

I might point out also, gentlemen, that our initial site that was proposed and that work was being done on locating feeder lines into this site was held up by the State Highway Department of South Carolina because it was found that it was in the immediate path of a new proposed bridge that will be built across the Savannah River. This necessitated work being done to find a new site that was acceptable and that would fit into the system.

So we have had numerous delays. We are proceeding on a schedule that we feel is as good as we can do. We ask that you gentlemen examine these dates and we hopefully would ask that you would go along with us and allow us to build this treatment plant as we schedule it because, as I told you at the beginning, we want to stop the pollution.

That concludes my statement.

MR. WHITE: Thank you, Mayor Walters.

Mr. Tinsley.

MR. TINSLEY: Yes, I have a couple of comments.

Mayor Walters, I hope that you will leave that proposed schedule with us.

MR. WALTERS: I have left her a copy, yes, sir.

MR. TINSLEY: That seems somewhat compressed on the front end, speaking of the schedule. The question comes to my mind as to what provision you and your consultant have made with respect to the planning requirements that you must comply with in receiving Federal funds.

MR. WALTERS: Mr. Zimmerman is here. But I believe we have complied with all of them--haven't we, Harry?--to my knowledge.

MR. ZIMMERMAN: Mr. Tinsley, the schedule the Mayor has presented assumes that we will build a single sewage treatment plant for the city of North Augusta.

MR. WHITE: Excuse me, sir. Would you step up to the rostrum and identify yourself for the record?

HARRY F. ZIMMERMAN

ZIMMERMAN, EVANS AND LEOPOLD

CONSULTING ENGINEERS

MR. ZIMMERMAN: Mr. Chairman, my name is Harry F. Zimmerman. I am a partner, senior partner, in the firm of Zimmerman, Evans and Leopold. We are consultants to the city of North Augusta.

In response to the question, the timetable that Mayor Walters has presented here states that we will meet specified dates contingent upon present criteria, and that present criteria means that the plant is a single plant serving only the city of North Augusta and located on the waterfront 1,000 feet below the Thirteenth Street Bridge.

Now, if the intent of the question that you proposed, Mr. Tinsley, was what regard do we have for a regional program, I must tell you that there is no regard presently with respect to a regional program.

MR. TINSLEY: I can't speak for the Federal establishment, but I understand that you do propose to utilize funds from the Environmental Protection Agency.

MR. ZIMMERMAN: Yes, sir, we have a grant offer and it has been accepted.

MR. TINSLEY: I really think that I could better direct my question to, say, Asa Foster, as far as that is concerned, but I would like to--

MR. WHITE: Well, I would like to kind of clear this thing up, while we have Mr. Zimmerman here, and ask Mr. Foster to come back up, if he would.

MR. FOSTER: Yes, sir.

MR. WHITE: Fine. I believe we have got you on the record.

Now, would you address your question to Mr. Foster?

MR. TINSLEY: Mr. Foster, what constraints will be placed on the city of North Augusta or what must they comply with to receive the Federal funds that are in question at this point?

MR. FOSTER: Well, the city of North Augusta already has a grant for this facility which was made before the requirement of a specific interim plan. The only way I know to address this question is that should a plan be developed that shows that North Augusta is not in compliance with or should the--I guess we have a COG here, a council of governments--should they develop a plan that North Augusta is not in compliance with, this may bring up questions.

But as I understand the regulations at this time, the city has a grant and has complied with the regulations we have asked them to comply with.

MR. TINSLEY: Then I would interpret this to mean that there is essentially a gray area where we really don't know specifics until we become specifically involved in it, is that a fair assumption?

MR. FOSTER: I would say that there probably is a gray area because we have a situation here where we have had continually changing requirements, and it seems to me that in this case all of the regulatory agencies should look at the situation in light of what is happening now since there has been some delay, as the Mayor mentioned, in getting the project to this point. The project has not started and I would hope that all of us would want to build the best for the area and for all parties concerned as near as we could.

What I am trying to say is that we should consider other alternatives if there are, in fact, other alternatives that are worth considering.

MR. TRAINA: To get to the specifics, with regard to the specific requirements of 18 CFR 601, the grant offer was made prior to that regulation. However, there is another requirement with regard to environmental impact statement that will have to go into some of the questions of alternatives. And that requirement, is that right, Mr. Foster, will have to be met as far as impact statement is concerned on this project?

MR. FOSTER: Well--

MR. WHITE: If I might say something here, would it not require an impact assessment statement and then a determination would be made as to whether or not a full-blown impact statement would be required?

MR. HOWARD: I think somebody ought to get the message up to Washington on the Potomac that the town of North Augusta and other towns in the same fix have had a lot of heat put on them by the State and by the Federal Government to get on with the program and they have established schedules. Now, they ought to be less ponderous and a little more liberal with their money and stop insisting on their going to another type of game with new ground rules, and so forth. This reminds me of the 1899 Act, if you want to know the truth of it. (Laughter.)

Now, they have got problems, as the Mayor said, problems of terms of office, bond referendum, and everything else. Some of these environmentalists and some of these people who think up things like NEPA ought to recognize the facts of life about some of these things.

MR. WHITE: Well--

MR. HOWARD: But somebody has got to tell them up there, you know?

MR. WHITE: Of course we are all here at this table concerned, and I am sure most of you in the room are concerned, with proceeding as rapidly as possible with abating these things, but we do have some hard realities that we have to consider and the National Environmental Policy Act is one.

I would pose this question, Mr. Foster. Is an assessment statement anticipated at this time or do you feel that this project preceded that requirement?

MR. FOSTER: Well, it definitely preceded that requirement just as it did the planning requirement. But here again, should there be objections, should objections arise and we find out that there are objections to North Augusta doing its own thing, we will say, then we would probably have to back up as we have in other cases.

But this is a determination of the Regional Administrator whether or not an impact statement is written. Our present regulations are not finalized, they are in a draft proposed form, but it is the Regional Administrator's decision whether he can make a negative declaration or require that we, EPA, write an environmental impact statement.

MR. WHITE: Well, I--

MR. HOWARD: John, I am not critical of you people. The thing is, I am saying this, that sometimes people forget the basic objective of this whole cleanup program is to clean up the water, not satisfy a bunch of bureaucrats, and so forth, about certain little dinky things that nobody can solve and I think we ought to put that on the record here.

MR. WHITE: Your point is well taken, Mr. Howard.

MR. HOWARD: Thank you.

MR. WHITE: And hopefully we can move this project along rapidly.

Before Mr. Zimmerman leaves, I would like to ask a question, sir.

How long has your firm been working on the plans and specifications? Have you started recently or how long have they been in preparation?

MR. ZIMMERMAN: Mr. Chairman, we are 30 percent complete with working drawings. Now, the process flow sheet has been submitted to South Carolina Pollution Control Authority and has approval and we are now, as I stated, 30 percent complete on the working drawings. Those drawings would be of no value if the size of the plant, the process or the location of the plant is changed.

And certainly, the plant, to fit into any regional program--and the regional program must be confined and limited to Horse Creek Valley and we are upstream some 6,000 feet from the confluence of Horse Creek and the Savannah River. To bring North Augusta into a regional program would destroy all the effort that has to date been expended in the interest of abating pollution.

And further, as you heard, the city of North Augusta is under cease and desist orders effective as of the 15th of next month. So all effort has been made to bring them beyond and within the scope of the order. Now, this certainly would delay, because no one has prepared a regional plan. It doesn't exist.

Thank you.

MR. WHITE: Thank you.

Mr. Tinsley.

MR. TINSLEY: Mr. Chairman, I have one additional question for Mr. Foster.

The grant offer was made under the existing 660 law which gives 33 percent.

MR. FOSTER: That is correct.

MR. TINSLEY: Considering the proposed legislation at the Federal level which is going to up the percent participation considerably, if the city of North Augusta plans to take advantage of those increases will they then have to prepare an additional interim plan?

MR. FOSTER: I wish I could--I really wish I had the answer, but I would assume, and I have not read the House--I have just received a copy of the House bill, a copy of the report on it, and I want to thank the State of Georgia for that. (Laughter.)

But I would assume that if the city of North Augusta is willing to play the game of taking a 60 percent grant, that they would have to play all the other little games that are involved in the act. That is my personal opinion and not--nothing to base it on except what I have learned in the past.

MR. TINSLEY: Let's back up one, then. The State of South Carolina is hopefully on the brink of having a State matching program which will allow the city of North Augusta or any other municipality to qualify for an increase in the Federal funds from 33 to 55 percent. Will there be any constraints with respect to interim plans on the city of North Augusta should the State matching program go through?

MR. FOSTER: Are you asking me, Ken? (Laughter.)

MR. TINSLEY: Yes. Your money will go from 33 to 55 percent with a State matching program.

MR. FOSTER: That is assuming that the law does not pass?

MR. TINSLEY: Presently.

MR. FOSTER: You are under the present law?

MR. TINSLEY: Yes.

MR. FOSTER: I don't know. I really don't know.

MR. TINSLEY: That is all that I have, Mr.Chairman.

MR. FOSTER: Because that provision, see, is still in the same act.

MR. WHITE: Mr. Traina?

MR. TRAINA: No.

MR. WHITE: Mr. Howard, any comments or questions?

MR. HOWARD: I pass, sir.

MR. WHITE: If not--

MR. WALTERS: Mr. Chairman, if I might make just one additional comment. This is no criticism, certainly, of anything that has been said, but there is a state of confusion. Dr. Webb when I talked with him, Mr. Tinsley, in my office indicated that a regional plan might be required. There is no regional plan. We can only assume that we will go ahead with what we have scheduled. We are not satisfied with the financing because under the present program in which we started this time schedule, the city of North Augusta is paying about 67 percent of the money and the Federal Government 33 percent.

The people of North Augusta when we instituted this sewer charge in September yelled to high heaven. The time has come, as Mayor Beckum says, that we simply have got to have some help in these municipalities. The people are looking for service. We can't provide it without money and you can't have money without a tax increase unless we get help from outside.

We are at a stage now where we are about to condemn property for the site of this plant. We have talked with consulting engineers day before yesterday. We have determined that the best site for this plant is in a certain location and the owner is not willing to sell us that property. We are going to have to condemn it. Now, we need to know in North Augusta from a regional standpoint should we go ahead with our plan to build our own plant or should we hold off until we can get an answer from someone on whether we are to go to Horse Creek Valley, whether we are to be piped across to Augusta, Georgia, or what are we to do.

We have developers who have borrowed money to buy land to build houses and, frankly, if we are faced with an imposition of a cease and desist order on building permits, these people face bankruptcy because they have made a commitment and have borrowed money and whether they make a principal payment on this or not there is an interest payment to be made and if they can't build a house and sell it they are in trouble.

So I am here today to tell you that we want to clean up the North Augusta problem. We are willing to go ahead and I am hopeful that we can get some additional financing so that the city won't have to pay 67 percent of it. We are going to try every way that we can, but we need to be told what direction do you want us to go and do I go into condemnation on this land or do I wait until I get an answer. If anyone can tell me, well, we will proceed as you suggest.

MR. WHITE: Mr. Mayor, I am not sure that we are going to come up with all the answers, but we certainly intend to address this problem and at least make some recommendations. At this point I don't know what they might be.

MR. WALTERS: Those are our problems and I appreciate the opportunity to come before this conference.

MR. WHITE: Any comments or questions now?

MR. TINSLEY: Thank you.

MR. HOWARD: I think in justice to the two mayors we have heard this morning we ought to point out that they have inherited these problems.

MR. WHITE: Well, I started to make that statement to

Mayor Walters.

MR. WALTERS: I have got one more year. I don't know whether I can delay that long or not. (Laughter.)

MR. WHITE: You came into a sticky situation, Mayor, there is no question about it.

MR. WALTERS: Yes. We want to have it, though, I assure you. We want to clear up this problem.

MR. WHITE: Thank you. We appreciate that attitude.

Thank you very much.

I would like to go off the record just a minute.

(Off the record.)

MR. WHITE: Let's go back on the record, please.

Mr. Hollis has now joined us at the head table here.

For the record, Mr. Hollis, would you identify yourself by title?

MR. HOLLIS: Yes, I am Charles H. Hollis. I am the Administrative Assistant to the South Carolina Pollution Control Authority.

MR. WHITE: Thank you. And I might say, too, that it is my understanding that Dr. Webb, whom we thought would be here, has the flu and couldn't make it.

MR. HOLLIS: Yes, Dr. Webb, I talked to him late last night, he had a high fever. He is hopeful that he will be able to be here tomorrow. If his health permits he does intend to be here tomorrow.

MR. WHITE: Fine. Thank you.

MR. HOWARD: Poor Dr. Webb caught that up in that filthy atmosphere of Washington last week (laughter). I was up there too.

MR. TRAINA: I didn't know flu bugs could exist in that environment.

MR. HOWARD: Right off the Potomac. (Laughter.)

MR. WHITE: Well, we are going to go back now to our original order of presentation. Mr. Howard assures me that the State's presentation is going to be very concise, unlike the verbosity by the Federal gentry here. (Laughter.) We will proceed and probably take a break for lunch in the next half hour to 45 minutes.

Mr. Howard.

MR. HOWARD: Mr. Chairman, I would like to call on Mr. Robert F. Magruder, who is the Division Manager of Environmental Protection for Continental Can Company. He will give a statement for Continental Can of Augusta, Georgia.

## R. S. MAGRUDER

### DIVISION MANAGER OF ENVIRONMENTAL PROTECTION, MILL OPERATIONS DIVISION

### CONTINENTAL CAN COMPANY

MR. MAGRUDER: Mr. Chairman and members of the conference.

I am R. S. Magruder, Division Manager of Environmental Protection, Mill Operations Division, Continental Can Company.

The Mill Operations Division is responsible for the operation of four kraft pulp and paper mills in the south, two in Georgia, these being located at Port Wentworth and Augusta. Our 725-ton per day bleached foodboard mill in Augusta is the facility to be discussed today.

Our purpose in requesting the privilege of making a statement is to review for you the history of the waste treatment facilities we are currently operating at the Augusta mill.

The major portions of the waste treatment plant were designed in 1958, and subsequently placed in service in 1960. This system initially consisted of a 177-foot clarifier, a sludge lagoon, and five extended aeration lagoons with a total area of 650 acres. The treated discharge from the lagoons reaches the Savannah River via Spirit Creek. In addition to wastes from the Continental Can plant, effluents from the adjacent Southern Glassine mill were also treated in the early 1960's.

In 1966, the capacity of the Augusta mill was increased and Cox Newsprint commenced operations. Through contractual agreements, Continental Can Company agreed to process the waste from Cox Newsprint, that is, in addition to that of Southern Glassine. As a result, the influent to the treatment facilities increased from 18 MGD to approximately 40 MGD, with corresponding increases in BOD and solids. The combined output of all of the associated manufacturing facilities increased from 500 tons per day to about 1,150 tons per day.

About two years after the expansion, the conclusion was drawn that the facility could only marginally handle the increased load. To compensate, No. 2 and No. 3 lagoons were converted to aerated basins through the addition of brush-type aerators. This added equipment provided some improvement but not enough, as indicated by data for 1970 and 1971, showing 80.8 percent BOD reduction average.

We recognize that this level of BOD reduction is not satisfactory and commit ourselves to meeting at least the current 85 percent requirement.

I would like to address for just a moment the aerial photograph on my right. This was taken during the Christmas shutdown after the mill had been down approximately 3 days. This (indicating) is the Continental Can facility, this (indicating) is Cox Newsprint, and this (indicating) is Southern Glassine.

Here (indicating) we have our clarifier, which in the photograph, with the mill being down, is empty. Our No. 1 pond (indicating), which is essentially a fiber trap and backs up the clarifier.

This (indicating) is No. 2 pond, the flow coming in at this point (indicating), circulating around the mid-feather and through these aerators (indicating). The discharge from No. 2 into No. 3 is at this point (indicating),where you see additional aeration.

The flow from No. 3 down through a ditch into No. 4 (indicating). No. 4 is an extremely shallow pond and as a result of the fact the mill had been down for 3 days the pond had drained and you see basically the bottom of the pond.

The flow from No. 4 extends through a canal through pipelines into No. 5 pond (indicating), where it travels around the mid-feather and discharges into Spirit Creek at this point (indicating).

Spirit Creek arises in here (indicating), comes down through the woods, across the railroad tracks into this point (indicating) very close to our discharge point, then follows the dike in this fashion (indicating), takes a short loop out into the swamp (indicating), and back, and discharges into the Savannah River at this point (indicating).

Gentlemen, I thank you for your kind attention. Are there any questions, Mr. Chairman?

MR. WHITE: Comments or questions?

MR. TRAINA: Mr. Howard?

MR. HOWARD: Go ahead.

MR. TRAINA: Thank you.

In your statement you indicate that you will commit yourself to meeting 85 percent requirement.

MR. MAGRUDER: Yes.

MR. TRAINA: The Federal report indicated a December 1972 date.

MR. MAGRUDER: Yes.

MR. TRAINA: Is this the date that you have in mind?

MR. MAGRUDER: We have two plans under active consideration at the present time with a commitment to the State Water Quality Control Board to give them an answer by May 1. Of the two plans, the first one, which considers additional aeration in these two ponds (indicating), could meet the December

1972 deadline.

The second plan, which involves the construction of a No. 6 lagoon (indicating), could not be met in 1972. It would be in late 1973.

MR. TRAINA: The report also recommends that the discharge after treatment, after the 85 percent treatment, go to the Savannah River--

MR. MAGRUDER: Yes.

MR. TRAINA: --rather than Spirit Creek. Have you considered that?

MR. MAGRUDER: Not in any great detail from an engineering standpoint. Without question it could be done, from an engineering standpoint. How we would do it, right now I am not prepared to say. Conceivably, running 8,000 feet of pipe down here would do it, so it could be done, yes.

MR. HOWARD: That is going to be a requirement from the State.

MR. LEDBETTER: Paul, I would like to add something to that point. We have been discussing this project with Mr. Magruder and some of their technical people and this is one of the things I think we will need to discuss in the executive session, is that if they talk about the December 1972 deadline, then he has got a problem of getting it to the river. I think we are all basically in agreement that that needs to be a serious consideration. By looking at his other alternative, that becomes much more of a feasible approach but it will be a little later date, and I think this subject is something we need to spend some time on in developing the recommendations.

MR. TRAINA: Mr. Magruder, a couple of other points.

With regard to color. Obviously your mill, as practically all paper mills, has a problem of color.

MR. MAGRUDER: Yes, sir.

MR. TRAINA: Are you thinking that through in terms of treatment down the road or feasibility studies, or so on?

MR. MAGRUDER: Yes, this is one of the things we are thinking through. We are very much aware of that problem. Continental Can has done considerable work in one of our other mills. The Federal Government has funded a project on color removal in unbleached kraft.

Now, this happens to be a bleached kraft mill and we have not made significant progress to date in removing the color from bleached kraft mills.

MR. TRAINA: Do you have any estimate as to when you might put something together in terms of some preliminary ideas?

MR. MAGRUDER: I do not, no.

MR. TRAINA: Low flow sheets as to what you might do with color?

MR. MAGRUDER: No.

MR. HOWARD: Paul, let me butt in here. That is something that we will discuss at the executive session, too. We have been talking to them about that and we want to do what is reasonable about that.

MR. TRAINA: Right.

MR. MAGRUDER: We are very much aware of the problem.

MR. TRAINA: We have this problem in all our paper mills.

MR. MAGRUDER: Yes, sir.

MR. TRAINA: Continental Can is no exception. They all have the problem.

One final point, and again maybe just for the record. Earlier we had some information about this mercury discharge that apparently was involving your effluent. Again, you know, I am just trying to find out, is this a problem with your mill?

MR. MAGRUDER: Well, I didn't realize it was a problem. Being a bleached foodboard mill, obviously we don't buy any mercury to use.

MR. TRAINA: Yes.

MR. MAGRUDER: The analysis that was reported on the 1899 application, permit application, was a single analysis that was run at the Institute of Paper Chemistry. There was a note made that inasmuch as it was a single point analysis it should not be considered representative of our discharge.

Now, where the problem is, whether it is in analytical procedures or what it might be, I frankly don't know.

MR. TRAINA: You are proceeding to gather the samples and clarify that point?

MR. MAGRUDER: Well, yes.

MR. TRAINA: I would suggest that you do just for your own satisfaction.

MR. MAGRUDER: Yes. We were not aware that this was a problem until this morning.

MR. WHITE: Well, the same point would apply to the zinc. But of course, now, these figures were taken from the application--

MR. MAGRUDER: That is correct.

MR. WHITE: --that was submitted by the mill.

MR. MAGRUDER: It was a single point analysis, a single analysis.

MR. WHITE: I would like to ask you about a figure that was also reported that indicates the oil and grease in pounds per day out of your effluent at 5,250 pounds. Can you speak to that?

MR. MAGRUDER: No, I would prefer not to address myself to that without reviewing the subject, frankly. There is no evidence, visual evidence, of this amount of oil and grease being discharged and it could well be that in the analytical procedures it is picking up something else that is giving a positive oil and grease reading. But you watch our discharge, there is no oil floating on the surface, that sort of thing. And we don't discharge that much from the plant.

In other words, our use of oil and grease is such that if we were losing 5,000 pounds a day it would be a very obvious and serious loss.

MR. WHITE: Well, obviously there needs to be some verification of these figures.

MR. MAGRUDER: Yes.

MR. WHITE: And possibly the conferees can address that problem.

MR. TRAINA: I would suggest, Mr. Magruder, you might want to submit something to us, you know, if you have some further information on those two problems, mercury and the grease business.

MR. MAGRUDER: All right.

MR.LEDBETTER: Paul, I think one of the recommendations that we come up with should be that we split samples, since this seems to be a question on a number of parameters, and let their consultants take a look at them and we will take a look at them as well as possibly your laboratory in Athens--

MR. TRAINA: All right.

MR. LEDBETTER: --and see if we can't get some clarification on this.

MR. WHITE: Hopefully that will resolve this.

Thank you, Mr. Magruder.

MR.MAGRUDER: Thank you.

MR. HOWARD: Thank you.

Mr. Chairman, I would like to now introduce Mr. Clem White, who is Vice President and General Counsel for Nipro, Inc., of Augusta. He has a prepared statement that we will ask him to read now.

## CLEM WHITE, VICE PRESIDENT
## AND GENERAL COUNSEL
## NIPRO, INC., AUGUSTA, GEORGIA

MR. CLEM WHITE: Mr. White, Mr. Howard, conferees.

As requested in the invitation, we have made our statement brief here. With me today is Mr. Tom Champion, our Director of Environmental Services, and Mr. Jack Richardson, Environmental Chemist, who will be available to answer questions that you might ask after the statement.

Nipro, Inc., and Columbia Nitrogen, in order to protect the environment, including the waters of the Savannah River, have installed and are prepared to further design, construct and install such facilities as are required to make certain their waste discharges are not harmful to the environment.

Nipro, Inc., is engaged in the manufacture of caprolactam, which product is a monomer used in the manufacture of nylon for textiles, tire cord, carpeting and plastics, and ammonium sulfate used largely for agricultural fertilizer applications. Nipro is at this time undergoing an extensive expansion program that will more than triple its capacity for making caprolactam.

Columbia Nitrogen Corporation is wholly owned by Nipro, Inc., and is engaged in the manufacture of ammonia, nitrogen solutions and nitrogen chemicals principally for agriculture.

As to the wastewater from Nipro, Inc., 90 percent of the original BOD containing waste from the process and a major portion of the nitrogenous waste are being sold for use by other manufacturing companies with whom the company has entered into supply contracts. The organic concentrated BOD, liquid waste, is and will be sold at transportation cost to manufacturing firms for incineration and reprocessing for them to recover the sodium content. The nitrogen-bearing inorganic waste liquor is sold for its nitrogen content at discounted prices. In order to insure continued disposal by sale to other companies, the company has constructed extra storage capacities for these two waste liquid flows.

The remaining 10 percent of the original BOD load and all sanitary waste in the effluent water will be treated in a secondary biological treatment plant. The BOD will thus be reduced to 2 percent of that originally in the process plant discharge before the plant effluent is finally wasted.

Because of unknown factors resulting from new processes in the plant expansion, we have planned further laboratory and engineering studies immediately upon startup of this expansion. These studies must be based on data obtained after the expanded plant is operating in order to show the real levels of contaminants in the final effluent. In case our biological treatment plant will not sufficiently reduce these contaminants to meet the Georgia Water Quality Control Board standards, we will have sufficient data at the end of 60 days, we estimate, for a process design enabling the engineering and construction of the equipment and facilities required to meet these standards.

The effluent waters from Columbia Nitrogen Corporation, containing nitrogen compounds, are discharged to a swamp and eventually enter Cason's Dead Lake. A comprehensive study to determine the fate of this effluent and its impact on the area is being carried out by a geological consulting firm, W. G. Keck and Associates, Incorporated. This study is scheduled to be completed in August 1972.

Concurrent with this study, another primary investigation has been undertaken involving the use of continuous ion exchange as an overall liquid effluent treatment. Initial study of this method was begun in 1970 following discussions with engineers of Chemical Separation Corporation of Oak Ridge, Tennessee, who developed and manufactured this system. Since May of 1971 work on this system has intensified such that by August of this year we will have sufficient technical information to allow final design of such a facility. This is in accord with a schedule submitted to the Georgia Water Quality Control Board on July 23, 1971, outlining our program to provide adequate waste treatment for the liquid effluents from the Columbia Nitrogen Corporation plant by the end of 1972.

Nipro, Inc., and Columbia Nitrogen Corporation have demonstrated since their formation a sincere interest in the

C. White

protection of water quality in the Savannah River. In addition to many development and engineering studies, the results of which have been transmitted to the regulatory agencies, these companies in 1963 engaged the consulting services of the Academy of Natural Sciences of Philadelphia for the purpose of monitoring that the Savannah River water quality was not affected by discharges from either of these corporations. These consulting services have continued and have included the following:

1. Three comprehensive river surveys, covering a stretch of the river several miles above and below the corporation's effluent outfalls;

2. A continuous river sampling program using diatometers, which has been maintained since 1963, and

3. A series of toxicology tests on the organic contents of the liquid wastes from the Nipro, Inc. plant.

By use of this information, the companies have been able to assure that the level of impurities in their discharges to the Savannah River has not affected the water quality. The most recent comprehensive river survey made by the Academy of Natural Sciences, at a cost of $25,000, was conducted in 197 about the same time that EPA made a survey. The report of the Academy survey and that of previous studies has been made available to the Georgia Water Quality Control Board.

Nipro and Columbia Nitrogen Corporation have and will continue to work in cooperation with and follow the recommendations of the Georgia Water Quality Control Board in its programs for pollution abatement.

We appreciate the opportunity, Mr. Chairman, to make this statement.

MR. HOWARD: Thank you, Mr. White.

Any questions, Mr. Chairman?

CHAIRMAN WHITE: I would like to raise one question again on the information submitted with the Refuse Act permit application. There is an indication that you have discharged 1,800 pounds of phenols per day. Are you planning anything, any special treatment, to take care of this or do you plan to run it through your biological treatment process or just what is planned there?

MR. CLEM WHITE: I am surprised at that information. I would like to ask Mr. Champion if he would comment on it.

CHAIRMAN WHITE: Fine, if you would come up, Mr. Champion, and identify yourself.

MR. CLEM WHITE: This is Tom Champion, Director of

Environmental Services for Columbia Nitrogen and Nipro.

TOM CHAMPION

DIRECTOR OF ENVIRONMENTAL SERVICES

NIPRO, INC., AUGUSTA, GEORGIA

MR. CHAMPION: I was quite surprised at the number. Could you repeat again where this number came from?

CHAIRMAN WHITE: Well, again from the Federal presentation previously, and possibly I should call Mr. Cloward to discuss this also. He made the presentation.

MR. CLOWARD: You were not here--

CHAIRMAN WHITE: Come on up to the rostrum, please.

MR. CLOWARD: I think I can answer the question.

CHAIRMAN WHITE: The material was presented to the conferees and there is an indication that there is a discharge of 1,812.5 pounds of phenols per day.

MR. CLOWARD: I think while you were out of the room, Mr. Chairman, I made the statement that we had that particular figure, but in this case I think that the particular analysis is picking up things other than phenols.

CHAIRMAN WHITE: I see.

MR. CLOWARD: So that it shows up as that number, but I question whether it is really truly phenols. This is something we are going to have to resolve.

CHAIRMAN WHITE: Then this is something likely that the conferees could address themselves to in the way of follow-up field work as we might have to in several cases, then.

That is the only thing that I have.

MR. TRAINA: Mr. White, in your plans, are you considering removing all discharges from Beaverdam Ditch? Presently you have a discharge of--

MR. CLEM WHITE: From Beaverdam Ditch?

MR. TRAINA: Yes, according to the Federal report?

MR. CHAMPION: We are now in the process of this study, as you notice.

MR. TRAINA: Yes, sir.

MR. CHAMPION: We are a little late in our study because we had high water down over the swamp, over Cason's Dead Lake, over Beaverdam Ditch. So we have a quite extensive sampling program all through this and we have presented this to Keck Associates, which you have been presented. This study is in process. We should have a report from Keck Associates this next week on this phase of the data. This we will present to the State immediately we get the report.

MR. TRAINA: So you don't know whether or not that study will recommend to you a removal of discharge from

Beaverdam Ditch?

MR. CHAMPION: Right.

MR. TRAINA: We will have to wait on that?

MR. CHAMPION: We will have to wait on the study.

MR. TRAINA: The reason I ask, the problems in those tributaries are very severe and we hope that we can remove as many of those discharges as possible from those tributary areas.

MR. LEDBETTER: Paul, if I might clarify that a little bit, their effluent travels parallel to the levee and enters Butler Creek down, you know, near the sewage treatment plant effluent, and it is quite a distance there and they are not entering anywhere near the same point as far as Beaverdam Ditch is concerned. I think the thing that we are really concerned about with this particular company is not so much the point that he is releasing it as whether the level of treatment is going to be proper to protect either the swamp, Cason's Dead Lake, etc., that it goes through, or whether we are contaminating groundwater or whether it should be diverted to the river. That is the reason we have asked them to bring in these consultants that are competent in this field of geology, and so forth.

MR. TRAINA: I see. Thank you.

MR. HOWARD: Thank you very much.

MR. CLEM WHITE: Thank you.

MR. HOWARD: Mr. Chairman, I would like to at this time introduce Mr. H. W. Hair, Jr., Plant Engineer for the John P. King Manufacturing Company of Augusta. Is Mr. Hair here?

H. W. HAIR, JR.
PLANT ENGINEER
JOHN P. KING MANUFACTURING COMPANY
AUGUSTA, GEORGIA

MR. HAIR: I may repeat, I am H. W. Hair, Jr., Plant Engineer for John P. King Manufacturing.

The reason I am here, I apologize, it is an informal format, and my part of this thing, I am just kind of like a little Indian running around outside playing with a tomahawk, you know, as far as importance, I think. But we wanted to give a report. We did not write a written report to the State. The directions said that you could give an oral report. Any time we can get this opportunity nowadays, we do.

Our problem is--well, we are an old textile plant, we were built in the late 1900's, and we employ about 700 people. Our problem here is separating sanitary from storm, getting sanitary into the city system. It is a very small amount of flow, so about 80 percent of what we have is sanitary, the remainder could be termed as process. We are not a wet process industry as such in textiles.

To date, our progress is 90 percent, we are delighted to report. We expect to have the other 10 percent completed by the end of April. We have had a few setbacks in our program schedule but nothing to compare with our neighbors in North Augusta.

Mr. Chairman, that concludes my report.

MR. HOWARD: Any questions?

MR. WHITE: I have none. Any others?

MR. HOWARD: Thank you, Mr. Hair. I appreciate it.

Mr. Chairman, that completes our presentation from our favorite polluters, but after dinner we will give a technical presentation.

MR. WHITE: Let's go off the record just a minute.

(Off the record.)

MR. WHITE: Let's go back on the record.

We stand recessed for lunch until 2:15.

(Whereupon, at 1:45 o'clock a noon recess was taken.)

AFTERNOON SESSION

WEDNESDAY, MARCH 22, 1972

2:15 o'clock

MR. WHITE: Let's go back in session, please.

I believe now we are going to go into the technical presentation by the State of Georgia.

MR. HOWARD: Mr. Chairman, I would like to present Mr. Leonard Ledbetter, Assistant Executive Secretary of the Georgia Water Quality Control Board. He is going to summarize our technical study and later on he will introduce our Director of Industrial Waste Service and our Director of Municipal Waste Service.

Leonard Ledbetter.

J. LEONARD LEDBETTER
ASSISTANT EXECUTIVE SECRETARY
GEORGIA WATER QUALITY CONTROL BOARD
ATLANTA, GEORGIA

MR. LEDBETTER: Thank you, Mr. Howard.

Mr. Chairman, ladies and gentlemen.

I am going to summarize our statement so that we can move along rapidly.

An in-depth water quality survey was conducted in the Augusta, Georgia, and Richmond County area by the Georgia Water

J. L. Ledbetter

Quality Control Board staff during July and August 1970. The study was coordinated with the Federal Water Quality Administration at that time in order to establish the total waste load to the Savannah River in the Augusta area. As the Environmental Protection Agency presentation reflected, the Federal personnel spent most of their time conducting a study of the Savannah River and its tributaries. The Georgia Water Quality Control Board staff studied in detail the industrial wastewater discharges in the Augusta area as well as the discharge from the city of Augusta's wastewater treatment plant and the various untreated wastewater discharges in the city and then the State published a report on this study in September 1970. This is the report that we published at that time.

During this same period, national attention was focused on the subject of mercury pollution and the associated problems. In cooperation with the Georgia Game and Fish Commission and the Environmental Protection Agency, the Water Quality Control Board has conducted several surveys regarding the mercury problem in the Augusta area in the Savannah River. As you know, the concentrations of mercury in the fish examined have exceeded the Food and Drug Administration's recommended level of 0.5 ug/g for edible fish. The State is continuing a surveillance program on a quarterly schedule to document the level of mercury in fish in the Savannah River below Augusta. A technical report was recently published by the State Water Quality Control Board on the complex problem of mercury pollution and we also have limited copies of this report available for interested parties.

The introduction in the Federal report states that there may be differences in the text of their report and the summary. Our study and documentation of the pollutional load from Georgia for this area established that 36,200 lbs/day of $BOD_5$ were being discharged to the Savannah River, which would be closer to 50 to 55 percent of the reported total waste load. Also the numbers that Mr. Cloward gave earlier this morning reflect approximately that same percentage.

However, the exact percentage from Georgia is not the important factor. An effective and prompt pollution abatement program is the order of the day as far as the State of Georgia is concerned, and this must include a contribution by all parties involved. At this time we feel that the municipalities and industries in Georgia have developed realistic abatement programs and are proceeding in a forthright manner to implement them.

Mr. Chairman, we would request that these two technical reports prepared by the State be made a part of the record. However, in the interest of reducing the volume of the proceedings and saving the taxpayers' money, we do not wish to make them a part of the proceedings. We have limited copies available in our office in Atlanta and we will be happy to make them available to interested parties if they will request them.

MR. WHITE: If I understand you right, we can accept these things for the official record and not reproduce them in the printed transcript of this proceedings, if you would like to do that.

MR. LEDBETTER: I would like to do that.

MR. WHITE: All right, we will accept them into the official record and they will not be reprinted in the transcript.

MR. LEDBETTER: Recognizing, you know, that many copies of the proceedings will be made, we just don't see the necessity of making such a voluminous copy of the proceedings.

MR. WHITE: I agree. Thank you.

MR. TRAINA: I pay taxes too and I am glad you made that decision.

(The above-mentioned documents, marked Exhibits 1 and 2, are on file in the office of the Environmental Protection Agency, Region IV, Atlanta, Georgia.)

MR. LEDBETTER: That concludes my statement, Mr. Howard.

MR. HOWARD: Thank you, Leonard.

If anybody wants copies of those reports who really have an interest, we will be glad to mail them to them from the Atlanta Office, but we don't like to just give them out, you know, and waste the taxpayers' money.

Now may I ask Leonard to introduce George Barnes, our Director of Municipal Waste Service. George will give a summary of the program that we have under way and the municipalities involved.

MR. LEDBETTER: He has already introduced you, George.

GEORGE D. BARNES
DIRECTOR, MUNICIPAL ENGINEERING
GEORGIA WATER QUALITY CONTROL BOARD
ATLANTA, GEORGIA

MR. BARNES: Thank you, Mr. Howard.

Mr. Chairman, ladies and gentlemen.

The following Georgia municipalities have wastewater discharges to the middle reach of the Savannah River. They are: Harlem, Columbia County, Augusta and Richmond County. Grovetown has no public sewerage at this time, but has a program for construction of sanitary sewers and a treatment facility which will discharge to this reach.

The city of Harlem has secondary treatment without disinfection. The city has submitted a program for adding chlorination and expanding the sewage collection system. A PL-660 grant application for fiscal year 1972 funds is currently being reviewed.

Columbia County has a program under construction to provide county sewerage which will eliminate existing small treatment facilities serving individual developments.

The problems in local waterways and the Savannah River in the Augusta-Richmond County area have been previously discussed. These problems are caused by the discharge of untreated wastes, including those from the Augusta system, overflows from the city's combined sewers and the discharge of partially treated waste from the Augusta Wastewater Treatment Facility. Augusta's program to correct these problems consists of construction of secondary treatment facilities, construction of additional sanitary sewers and flow diversion structures and separation of sanitary and stormwater sewers.

A permit for the construction of secondary treatment facilities has been issued to the city of Augusta by the Georgia Water Quality Control Board, and the plant is scheduled to be in operation by July 1973.

Separation facilities to correct existing problems in

Oates Creek and the Camille Street ditch due to raw sewage discharges are scheduled to be completed by July 1973.

Plans and specifications for construction of diversion structures necessary to eliminate some of the existing raw sewage outfalls into the third level of the Augusta Canal were submitted to the Georgia Water Quality Control Board for approval on March 15, 1972. It is estimated that seven months will be required to construct these facilities. Engineering plans for diversion structures to eliminate the other existing raw sewage outfalls to the third level of the canal are scheduled to be submitted for approval in September 1972, and it is estimated that 12 months will be required for construction.

Separation of sanitary and stormwater sewers is being done on an individual project basis by the city whenever roadway or storm drainage improvements are made. Plans are currently being prepared to provide sewer separation in the Fifteenth Street area in coordination with new highway construction. Plans have been prepared to separate combined sewers in the downtown area, and separation in Seventh Street between Broad Street and Reynolds Street has been completed. The cost of this work greatly exceeded estimates, and when extended to estimate the cost of separation of the entire system, the project was found to be beyond the city's present financial capability.

We have prepared a table showing the status of the municipalities which have previously been discussed and we would like to include it as part of our statement.

MR. WHITE: Fine. They will be accepted in the record.

(The above-mentioned tables follow:)

## GEORGIA MUNICIPAL SEWERAGE SYSTEMS DISCHARGING TO MIDDLE REACH OF THE SAVANNAH RIVER

| Municipality | Present Treatment | Receiving Stream | Present Status and Comments |
|---|---|---|---|
| Harlem | Secondary | Uchee Creek | Effluent disinfection will be provided under program which is currently being considered for Federal grants |
| Grovetown | No public sewerage | Uchee Creek | City currently has PL-660 grant and arrangements are being made to obtain other funds to construct sewers and secondary treatment |
| Columbia County | | | |
| Crawford Creek Area | Small secondary treatment facilities with effluent chlorination | Crawford Creek | 0.5 MGD secondary treatment facility is under construction and scheduled to be placed in operation by June 1972. The new plant will eliminate existing small facilities |
| Reed Creek Area | Small secondary treatment facilities with effluent chlorination | Reed Creek | 1.7 MGD secondary treatment facility will be under construction this year and will eliminate existing small facilities |

| Municipality | Present Treatment | Receiving Stream | Present Status and Comments |
|---|---|---|---|
| Augusta - Richmond County | | | |
| Augusta Wastewater Treatment Facility | Primary with effluent chlorination | Butler Creek | 30 MGD secondary treatment scheduled for completion in July 1973 |
| Oates Creek & Camille Street Ditch | None | Butler Creek | Contract has been awarded for separation facilities to eliminate discharge. These are scheduled to be complete by July 1973. |
| Second and Third Level of Augusta Canal | None | Savannah River | Diversion structures to eliminate existing raw sewage outfalls scheduled for completion by September 1973 |

MR. BARNES: That concludes my statement.

MR. HOWARD: Thank you, George.

Questions?

MR. TRAINA: Mr. Barnes, with regard to this collection system that is ongoing, would you estimate when it is completed the percent of the Augusta area that will be served then by sewage collecting facilities on treatment?

MR. BARNES: I couldn't tell you. We could probably call on Mr. Massoy. I think essentially the entire city will be served by the collection system. The main work that this covers is not construction of sewers, it is construction of diversion structures to take the existing outfalls out of the canal into the intercity interceptor which is already in place.

MR. TRAINA: On the separation, I can appreciate the cost. Have you made an estimate of the costs involved in separating the entire--

MR. BARNES: The city's consultants made an estimate based on the amount of work that actually was let to contract and they estimate that the program would cost about $9 million. I am sure that by the time they got around to doing it, it would probably end up costing about twice that.

MR. LEDBETTER: Paul, I think what George's statement really reflects is that this program that the city has under way at the present will result in all the sanitary sewage during dry weather flows being collected and diverted to the new secondary treatment facility approximately at the time the plant is placed into operation or within a few months after that.

Now, we don't have an exact date for the completion of each individual contract that they may let, do we, George? But basically that is the essence of what we are saying, is that the city will pick up all dry weather flow as far as the sanitary sewage and divert it to the sewage treatment plant about the time it is placed into operation or shortly thereafter.

MR. BARNES: That is correct.

MR. TRAINA: So we will have the remaining problem of storm sewer which we have in many other areas?

MR. LEDBETTER: But we plan to cover that in the recommendations, as you know, as the report also refers to.

MR. WHITE: I don't have any questions. Mr. Tinsley?

MR. TINSLEY: No questions.

MR. HOWARD: Thank you, George.

MR. LEDBETTER: Our next representative from the staff will be Mr. William Jernigan, Director of the Industrial Waste Service of the Georgia Water Control Board, and he will give us a rundown on the status of the industrial projects in this area.

WILLIAM M. JERNIGAN, DIRECTOR
INDUSTRIAL WASTE SERVICE
GEORGIA WATER QUALITY CONTROL BOARD
ATLANTA, GEORGIA

MR. JERNIGAN: Mr. Chairman, ladies and gentlemen.

The following comments will review briefly the present status of the program for industrial wastewater abatement on the Georgia side of the Savannah River for the city of Augusta and Richmond County areas.

In July and August 1970 water quality investigations of these areas were conducted by personnel of the Georgia Water Quality Control Board. A number of industries were found to be discharging untreated process and domestic wastewaters to the various streams and canals. A list of these industries and the present status of their abatement programs is attached. Also attached are letters from some of these industries, giving a current status report of their programs in response to the hearing notification. We would like these to be made a part of our statement.

MR. WHITE: They will be accepted into the record as if read.

(The above-mentioned letters follow:)

## AUGUSTA-RICHMOND COUNTY INDUSTRIES
## INDUSTRIES NOW CONNECTED TO PUBLIC SANITARY SEWER

| NAME | TYPE OF PRODUCTION | TYPE OF WASTEWATER | ESTIMATED VOLUME OF WASTEWATER MGD | TREATMENT PROVIDED |
|---|---|---|---|---|
| Augusta Chemical Co. | Textile dyes | Organic acidic | 0.013 | Neutralization, sedimentation |
| Augusta Plating Co. | Metal plating | Cd, Cr, Cu, Zn, Cn, plating wastes | 0.010 | - |
| Castleberry's Food Co. | Canned meats | Organic | Unknown | - |
| Graniteville Company | Cotton textiles | Dye, slasher, domestic | | |
| Enterprize Division | | | Unknown | - |
| Sibley Division | | | 0.280 | - |
| Riverside Mills | Wool processing | Organic, acidic | 0.300 | - |
| Shapiro Packing Co., Inc. | Meat packing | Organic | Unknown | Grease removal, screening |
| Swift Fresh Meats Co. | Meat cutting | Organic | Unknown | - |

### AUGUSTA-RICHMOND COUNTY INDUSTRIES
### INDUSTRIES NOT CONNECTED TO PUBLIC SANITARY SEWER

| NAME | TYPE OF PRODUCTION | TYPE OF WASTEWATER | EST. VOLUME OF WASTEWATER, MGD | TREATMENT PROVIDED | RECEIVING STREAM | STATUS |
|---|---|---|---|---|---|---|
| Babcock & Wilcox | Firebrick | Kaolin, gypsum sawdust | 0.070 | Sedimentation | Unnamed tributary to Rocky Creek | Existing facilities hydraulically overloaded. Program to reduce wastes by redesigning molds is underway. |
| Buckeye Cotton Oil Div. of Buckeye Cellulose Corp. | Cottonseed & soybean meals & oils | Suspended & floating organics & oils | 0.300 | Oil separation & neutralization | Camille St. Ditch to Beaverdam Ditch | Scheduled to connect to Augusta sanitary sewer by September 1972. |
| Burris Chemical, Inc. | Sodium hypochlorite | Chloride solutions & cooling water | 0.054 | Retention pond | Savannah River | Construction permit issued October 1970. Retention pond does not generally overflow |
| Cities Service Corp. (formerly Tennessee Corp.) | Chemical | Acid, solids cooling water | 4.0 | Settling pond | Savannah River | Construction permit issued August 1966 for cooling water; construction permit issued November 1967 for acid and solids settling pond operated to date without overflow. |
| Columbia Nipro Corp. | Chemical | Organics | 1.372 | Activated sludge | Savannah River | See separate statement |
| Columbia Nitrogen Corp. | Chemical | Nitrogen | 1.78 | None | Savannah River | See separate statement |
| Continental Can Co. | Pulp & paper | Pulp & paper | 45.0 | Primary clarifier, aerated pond, waste stabilization ponds | Savannah River | See separate statement |

| NAME | TYPE OF PRODUCTION | TYPE OF WASTEWATER | EST. VOLUME OF WASTEWATER, MGD | TREATMENT PROVIDED | RECEIVING STREAM | STATUS |
|---|---|---|---|---|---|---|
| E. I. duPont de Nemours & Co. | Sodium silicate | Inorganic caustics | 0.010 | Neutralization, sedimentation | Butler Creek | Construction permit issued May 1971; system in operation but requires minor improvement. |
| I.M.C. (International Minerals & Chemicals Corp.) | Granular fertilizer | Scrubber wastewater | - | Sedimentation & recycle | None | Operating permit issued May 1971; system operating with no discharge. |
| J. P. King Mfg. Co. | Cotton textiles | Dye, slasher, & domestic | 0.030 | - | Savannah River | Scheduled to connect to Augusta sanitary sewer by April 1972. |
| Monsanto Chemical Co. | Phosphoric acid products | Cooling water, boiler blowdown, leaks & spills | 0.100 | Cooling ditch & emergency | Butler Creek | Construction permit issued December 1970; system in operation but requires more operating data before an operating permit is issued. |
| Olin Chemical Co. | Chemical | Mercury, solids, cooling water | 3.0 | - | Savannah River | See separate statement. |
| Philadelphia Quartz Co. | Sodium silicate | Inorganic caustics | - | Two holding ponds, recycle | Savannah River | Construction permit issued May 1971 for recycle system. Filter operational problems are under study. |
| Ponderosa Georgia Corp. | Waste paper repulping | Organic, solids | - | Makeshift holding ponds, partial recycle | City sewer or Butler Creek at times | Improved pretreatment facilities under design with scheduled completion by September 1972. |
| Scott Meat Packers, Inc. | Beef & pork slaughtering | Blood, wash water | 0.012 | None | Rocky Creek | No schedule submitted to provide treatment or connect to public sanitary sewer. |
| Southern Wood-Piedmont Co. | Wood treating | Creosote, oils | 0.010 | Sedimentation, oil separation | Rocky Creek | Scheduled to provide pretreatment by July, 1972 and connect to Richmond County sanitary sewer when available. Pretreatment facilities are under construction. |

MR. JERNIGAN: Several of the industries have or will soon complete their programs. However, it should be noted that in many cases the industrial wastes are being diverted to the public sewerage system.

The major sources of industrial wastewater discharges require separate presentation. Based on our recent investigations and latest reports from the industries the current status is as follows:

Columbia Nitrogen Corporation. There are two plants at Augusta associated with this corporation and are to be reported separately.

The first plant is the nitrogen plant. This plant discharges about 1,000 gallons per minute of cooling water contaminated with nitrogen compounds as reported on page 16 of the Environmental Protection Agency's report of August 1971, revised February of 1972. In July 1971 the company submitted a schedule to the Water Quality Control Board for conducting engineering studies of this discharge. Weather conditions delayed completion of data collection until the earlier part of this month. The schedule submitted by the company calls for the final engineering report on necessary modifications or upgrading to their present nitrogen plant cooling water disposal system to be completed by August 15, 1972.

W. M. Jernigan

Nipro, Inc. This is the caprolactam plant which was operated previously under the name of Columbia Nipro Corporation. The original plant, which was started up in 1966, is undergoing an expansion in production from about 22,000 tons per year of caprolactam to 77,000 tons per year. About 1.0 MGD of uncontaminated cooling water is to be collected in a separate sewer system and discharged to the same swampy area as the cooling water from the Columbia Nitrogen Corporation. The total raw waste load to be expected from the expanded plant is about 190,000 lbs/day of $BOD_5$. Through a combination of sending a portion of this wastewater to pulp and paper mills for byproduct recovery and modifications and upgrading of an existing activated sludge plant, the company is proposing to provide secondary treatment for 0.4 MGD with a discharge of 4,500 lbs. $BOD_5$ per day or less, which reflects 97.6 percent total reduction for this plant's raw waste load.

Continental Can Company. This is a kraft pulp mill producing about 700 to 800 tons of pulp per day with some bleaching. The Cox Newsprint Company, located nearby, buys some of its pulp from the Continental Can Company and produces about 300 to 400 tons of paper per day. Wastewaters from both plants are treated in the system described on page 19 of the Environmental Protection Agency's report of August 1971, revised February 1972. The facilities do not consistently provide adequate secondary biological treatment nor are the sludge lagoons controllable due to influx of considerable storm runoff. Engineering reports have been submitted to the Georgia Water Quality Control Board presenting two schemes for providing consistent 85 percent $BOD_5$ reduction for an influent wastewater base load of 68,000 lbs/day and for providing necessary modifications to the sludge lagoon system. One scheme involves the installation of additional aeration which could be completed by the end of 1972. The other scheme involves the construction of an additional 280-acre lagoon with relocation of the discharge from Spirit Creek to the Savannah River, but could not be scheduled for completion prior to December 1973 because of land clearing and construction involved. The company is presently reviewing both schemes and will advise the Water Quality Control Board not later than May 1, 1972, the one they will propose to the Board.

Olin Corporation. The Augusta plant of the Olin Corporation produces caustic soda and chlorine by electrolysis of a purified brine solution. Wastewater from the plant contains dissolved salt, free chlorine, dissolved chlorine and mercury. Prior to May 1970 the plant was discharging approximately 12 lbs/day of mercury. The plant was then directed by the Georgia Water Quality Control Board to immediately reduce their discharge to below 0.25 lbs/day and proceed with a program to essentially eliminate mercury in their effluent. In February 1971 a construction permit was issued by the Water Quality Control Board for disposal facilities consisting of a series of in-plant modifications and treatment facilities to provide for elimination and recovery of mercury and reduction of caustic and chlorine. The treatment facilities and most of the in-plant modifications have been completed, with the last change scheduled for completion by April of this year. The facilities are to be maintained and operated in such a manner as to essentially eliminate all mercury from the wastewater discharge. Recent operating reports from Olin show weekly average mercury discharges of less than 0.10 lbs/day.

Mr. Chairman, that concludes my statement.

MR. WHITE: Thank you, Mr. Jernigan.

Comments or questions?

MR. TRAINA: One quick question, Mr. Jernigan.

With regard to the Continental Can situation, have you fellows made any studies as to what effect, say, in terms of dissolved oxygen in Spirit Creek, that a discharge of that facility after 85 percent treatment would have? These two schemes, if in fact they were to go to Spirit Creek, with an

85 percent, would that reduce oxygen, say, below 4 in Spirit Creek, if you know?

MR. JERNIGAN: It is below 4 now.

MR. TRAINA: I realize that.

MR. JERNIGAN: With the new schemes there will not be a great deal of change in Spirit Creek. The system at this time will achieve 85 percent reduction except during the winter months of the year.

MR. TRAINA: So you would not expect the dissolved oxygen to be above 4 in Spirit Creek if in fact--

MR. JERNIGAN: The situation will not change from what it is right now.

Thank you, Mr. Chairman.

MR. HOWARD: Thank you, Bill.

MR. WHITE: Thank you.

MR. HOWARD: Mr. Chairman, that completes our presentation unless there are some questions that somebody wants to ask or unless some of our industrial friends want to add anything to what we have said or dispute anything we have said.

MR. WHITE: Well, we might issue the call now to see if there is anyone else from Georgia who would like to make a comment at this time.

If not, thank you, Mr. Howard.

J. L. Ledbetter

(The following written statements were entered into the record by Mr. Ledbetter:)

**Babcock & Wilcox**

Refractories Division

P.O. Box 923, Augusta, Ga. 30903
Telephone: (404) 798-8000

March 13, 1972

RECEIVED
MAR 14 1972
WATER QUALITY
CONTROL

Mr. R. S. Howard, Jr.
Executive Secretary
Georgia Water Quality Control Board
47 Trinity Avenue S.W.
Atlanta, Ga. 30334

Dear Mr. Howard:

This letter is to acknowledge your invitation for the March 22, conference in Augusta concerning pollution of interstate waters of the Savannah River, Middle Reach, Georgia - South Carolina. We are naturally concerned with the water quality of this region and our role in protecting it.

A representative from this plant will attend the conference, but will not make an oral statement. This letter will serve as the written statement of the status of this plant's wastewater abatement program.

The primary concern of wastewater at this plant is from a wet molding process. Wastewater leaving this process contains kaolin, gypsum and sawdust. Over the last year a program was conducted to improve the quality of the wastewater by reducing the solids and water wasted at the source. It is our opinion that the wastewater is of a quality not to be unsightly or to interfere with the legitimate use of the water. Since the material wasted represents a monetary loss, we plan to continue efforts to reduce these wastes at the source. We are presently redesigning our molds to closer tolerances and are convinced this will add to the quality of the wastewater.

We look forward to attending this conference and believe it will aid in coordinating pollution abatement activities in this region.

Sincerely,

THE BABCOCK & WILCOX COMPANY

Hal M. Armstrong

Hal M. Armstrong
Section Manager, Projects
Facilities Engineering

HMA:emk
cc: LHLamar
RPStuntz
GRChesnut
FMLide

BUCKEYE COTTON OIL DIVISION
OF
THE BUCKEYE CELLULOSE CORPORATION
P. O. BOX 911
AUGUSTA, GA 30903

March 15, 1972

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MAR 16 1972
GEORGIA
WATER QUALITY
CONTROL

State Water Quality Control Board
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

Attn: Mr. R. S. Howard, Jr.

Dear Mr. Howard:

This is in answer to your request of 3-7-72. I plan to attend the conference but do not plan to make a statement.

We have completed our in-plant alterations and have received bids for the sewer line from the plant to the proposed city sewer. A contract for our sewer line will be placed within the next few days and construction should be completed within 60 days of the completion of the city line.

The contract for the proposed city line has been placed, and we understand from our consultant engineer, Zimmerman, Evans, & Leopold, (also the city consultant) that construction will start right away.

Yours truly,

R. A. French

RAF:jw

CITIES SERVICE COMPANY
CITIES SERVICE BUILDING
3445 PEACHTREE ROAD, N. E., ATLANTA, GEORGIA

TWX 810 - 751-3147
TELEX 54-2247
P. O. BOX 50350
ATLANTA, GEORGIA 30302
(404) 261-8100

INDUSTRIAL CHEMICALS DIVISION
Satellite Plant Group

March 15, 1972

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MAR 16 1972
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WATER QUALITY
CONTROL

Mr. R. S. Howard, Jr.
Executive Secretary
State Water Quality Control Board
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

Dear Mr. Howard:

Thank you for inviting us to participate in the conference on March 22 in Augusta on pollution of the interstate waters of the Savannah River.

Mr. P. D. Lanier, plant manager of our Augusta sulfuric acid and alum plant manufacturing facilities, plans to attend this conference but does not propose to make either an oral or written presentation at the conference.

We are interested in the quality of the Savannah River water and obtained construction permits for waste water facilities for both our sulfuric acid and alum plants before construction of either of these plants was begun. The construction permit for our acid plant is #66070 C dated 8/31/66 and is for discharging 4.0 mgd of cooling water at approximately 119° F. into a drainage ditch leaving our property. According to both your and our samples and records we are operating within the limits of this construction permit. This discharge consists of untreated river water which has been used for cooling purposes only. The cooling water is discharged from the plant property by a drainage ditch and travels for about 200 yards to an unnamed swamp. The unnamed swamp flows for about 3 miles where it joins Cason's Dead River. Cason's Dead River then joins Butler Creek which discharges into the Savannah River.

Our construction permit for waste treatment facilities for the aluminum sulfate plant is #67-136-C dated 11/14/67. This permit is for construction of a large ponding area to receive all waste water from the aluminum sulfate plant. This permit states that any effluent from this plant is to be essentially free of suspended solids and to contain no toxic elements. It also states sludge is to be removed as necessary to prevent carryover. Since the beginning of operation of this plant in 1968 there has been no discharge of any kind from this pond.

Very truly yours,

Fred E. Rowe, Manager
Satellite Plant Operations

FER:agh
cc: Mr. P. D. Lanier

Graniteville
COMPANY

GRANITEVILLE, SOUTH CAROLINA 29829

803-663-7231

March 10, 1972

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MAR 13 1972
GEORGIA
WATER QUALITY
CONTROL

State Water Quality Control Board
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

Attention: Mr. Wayne B. Roberts, P. E.
Industrial Waste Service

Subject: Your letter of March 2, 1972
Enterprise Division
Augusta, Georgia

Dear Mr. Roberts:

This is to advise you that our Enterprise Division has not been connected to the City of Augusta sanitary sewer. A sanitary sewer is not yet available and the Augusta City Engineer, Mr. James B. Messerly advises that they will have their City sanitary sewer installed sometimes within the next year. When the City sanitary sewer becomes available, we will connect our Enterprise sewers.

Yours truly,

GRANITEVILLE COMPANY

H. A. Woodhead, Supt.
Engineering Dept.

HAW/lj

CC: Mr. Jerry Johnson

RAINBOW DIVISION
14 PERIMETER CENTER EAST, N.E. • ATLANTA, GEORGIA 30328
TELEPHONE: AREA CODE 404 • 296-9540

IMC

INTERNATIONAL MINERALS & CHEMICAL CORPORATION

March 14, 1972

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WATER QUALITY
CONTROL

State Water Quality Control Board
47 Trinity Avenue, S.W.
Atlanta, Georgia 30334

Attn: Mr. R. S. Howard, Jr.
Executive Secretary

Dear Mr. Howard:

This is in reply to your letter of March 7th addressed to Mr. J. C. Kennedy, the manager of our plant in Augusta. Your letter invited Mr. Kennedy to attend and participate in the conference scheduled for March 22nd at the Holiday Inn in Augusta on the subject of pollution of the Savannah River. Your letter further asked that our company provide your office with a brief status report on our wastewater abatement program.

Mr. Kennedy will probably not be able to attend the conference and our company does not plan to make a statement at the meeting. I have, however, prepared the status report on our abatement program which is given in the following paragraphs.

Water consumption at our Augusta plant on Molly Pond Road is now approximately 13,000 gallons per day. Of this 3,000 gallons is used as boiler feedwater, 9,000 gallons is used in the scrubber and less than 1,000 gallons is used for drinking, toilets and showers.

The boiler water is converted to steam which is subsequently used as an agglomeration agent in our fertilizer granulation process. This water is removed by evaporation in the dryer.

The heated dryer air, and the unheated cooler air is passed thru a wet scrubber. The 9,000 gallons of water per day which is passed over the scrubber removes dust particles and cleans these two air flows before they are released to the atmosphere.

....continued....

90% of the water used in this fashion is lost to the atmosphere as evaporation. The remaining 10% portion is thickened in a surface containment basin, the suspended solids removed, and the water is returned to the process. There is no release of any of this scrubber water to surface drainage or to sewers. The solids deposits are salvaged as product.

The sanitary water is processed thru the septic tank system.

I trust the brief report, as given above, meets the requirements of your group. If there are any questions, please contact me at our Atlanta Office address as given on the letterhead.

Very truly yours,

J. L. Medbery

J. L. Medbery
Manager of Fertilizer Technology

JLM/gb

cc: D. L. Dibble-Atlanta
J. C. Kennedy-Augusta

Monsanto

MONSANTO INDUSTRIAL CHEMICALS CO.
P. O. Box 1473
Augusta, Georgia 30903
Phone: (404) 798-4346

March 10, 1972

RECEIVED
MAR 15 1972
GEORGIA
WATER QUALITY
CONTROL

Mr. R. S. Howard, Jr., Executive Secretary
State Water Quality Control Board
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

Attention: Mr. Bill Jernigan

Reference: Letter from Mr. Howard to the undersigned, dated 3/7/72, concerning the EPA Conference scheduled for Augusta on March 22, 1972.

Gentlemen:

The status of Monsanto's Augusta Plant Waste Water Abatement Program is as follows:

A. Background:

The Plant is located on Marvin Griffin Road, Richmond County, Georgia, and since 1962, has manufactured phosphoric acid and sodium phosphates. One plant effluent averages less than 25 gpm and flows into Butler Creek. This effluent is made up primarily of cooling water, boiler blowdown and ground water. A second 25 gpm waste water stream goes into the county sewer. It is made up basically of cooling water with sanitary sewage for 30 persons, laboratory reagent chemicals and occasionally small amounts of sodium phosphates being the remaining constituents.

B. Status:

1) The Plant has continuously operated, since July 15, 1971, a chemical spill alert and containment pond system constructed on State Permit Number 70-258-C. The application for an operating permit is currently being prepared.

2) We routinely report to you the results of our effluent monitoring program which includes Butler Creek.

3) More detailed effluent information is available as a result of work done to submit an application for a Corps of Engineers Discharge Permit and the Report of Industrial Discharges (Form 7500-1) to EPA.

We will be pleased to answer any further questions which may arise.

Very truly yours,

George D. Rozelle
Technical Supervisor

GDR:et

397

CHEMICALS

**PHILADELPHIA QUARTZ COMPANY**
PUBLIC LEDGER BUILDING · INDEPENDENCE SQUARE · PHILADELPHIA, PA. 19106
AREA CODE 215 · MArket 7-7200
Established 1831

P. O. BOX 5301
AUGUSTA, GA. 30906

March 13, 1972

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MAR 14 1972
GEORGIA
WATER QUALITY
CONTROL

Mr. R. S. Howard, Jr.
Executive Secretary
State Water Quality Control Board
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

Dear Mr. Howard:

This letter is in reply to your March 7, 1972 request for a brief status report of our plant's wastewater abatement program and completion schedule.

The Philadelphia Quartz Company plant in Augusta, Georgia, completed the construction of its industrial wastewater recycling system on December 23, 1971. When this system was placed into operation on January 3, 1972, a filtering problem was encountered and this is currently being pursued.

Since our production facilities were down for the month of February, we were not in a position to test various filter media suggested to us by our filter suppliers. Now that production has started again, we will be able to concentrate on solving this problem.

It should be noted that no wastewater effluent has been discharged off of our property since March 4, 1972 when various trials were started in the effort to finding an answer to our filtering difficulties. Certainly within a couple of months, this situation should be remedied and then with a satisfactory operational system, we can apply for the necessary permit. In the meantime, we do not anticipate or foresee any industrial waste effluent leaving our property.

Very truly yours,

PHILADELPHIA QUARTZ COMPANY

R. G. Webster, Plant Manager
Augusta Plant

RGW/csd

cc: Mr. James W. Sheffer
Philadelphia Office

W. M. HALL
G. R. RICH
W. J. LESSARD
C. A. DAUBER
BAUMRUCKER

MAIN
CHAS. T. MAIN, INC.
*Engineers*

1301 EAST MOREHEAD STREET, CHARLOTTE, NORTH CAROLINA 28204 • Telephone 704-375-1735
Home Office: Southeast Tower, Prudential Center, Boston, Massachusetts 02199 • Telephone 617-262-3200

March 17, 1972

2889-2

**Subject:** Ponderosa Georgia Corporation
Augusta, Georgia
Wastewater Abatement Program Status

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MAR 20 1972
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Mr. R. S. Howard, Jr.
Executive Secretary
Georgia State Water Quality Control Board
47 Trinity Avenue, SW
Atlanta, Georgia 30334

Dear Mr. Howard:

On behalf of our client, Ponderosa Georgia Corporation, we are submitting this brief status report of their wastewater abatement program.

Upon receipt of your letter of March 7, 1972, Mr. Kelley requested MAIN to represent Ponderosa Georgia at the March 22, 1972 Conference on the Savannah River, Middle Reach. We agreed to this representation and in his letter of March 10, 1972 to you, Mr. Kelley indicated that we will register and make a statement. Subsequent events dictate that an oral statement should not be made by us in their behalf at the Conference. Accordingly, this status report is made pursuant to the request in your March 7 letter.

During the past five months we have been working with Ponderosa Georgia Corporation to outline and assist in the implementation of their wastewater abatement program. This activity has included analytical and experimental work required to secure admission of a portion of their wastewater flow into the City of Augusta sewer and wastewater treatment plant. An interim pre-treatment facility has been built to provide an effluent which is acceptable by the City of Augusta. Also a larger, more efficient pre-treatment facility is being planned for immediate construction. Bids have been received for this work and contract documents are in the final stages of preparation. A 12' diameter by 16' long vacuum belt filter, several pumps and other pertinent items of equipment have been placed on order. Completion of the necessary pipe lines, structures and equipment installation is scheduled for September 31, 1972.

It is anticipated that with completion of the proposed pre-treatment facility, volumetric balance will be achieved between fresh water make-up required in process and treated waste water which can be discharged to the Augusta City sewer. The pre-treatment facilities have been discussed with Mr. Jim Messerly, City Engineer, Augusta, in general terms only. It is expected that completed plans and specifications for these facilities will be submitted to Mr. Messerly along with the Industrial Sewer Connection Application within several weeks.

If you need additional information, please call us.

Yours very truly,

CHAS. T. MAIN, INC.

By: Charles H. Davis, Jr.
Charles H. Davis, Jr.

CHDjr/hs

cc: J. B. Messerly
W. L. Kelley
Will Tetreault

P.O. Box 5447
Spartanburg, S.C. 29301

Phone 803/583-4551

**Southern Wood Piedmont Company**

March 15, 1972

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MAR 16 1972
GEORGIA
WATER QUALITY
CONTROL

State Water Quality Control Board
47 Trinity Avenue, S.W.
Atlanta, Georgia 30334

Attention: Mr. R.S. Howard, Jr., Executive Secretary

Dear Mr. Howard:

Reference is made to your letter of March 7, 1972, concerning the pollution abatement conference to be held in Augusta on March 22, 1972.

Our wastewater abatement system is designed to be a primary treatment system with the effluent scheduled to enter the Richmond County sewer line upon it's completion along Nixon Road. Our system is designed to remove preservatives from the effluent. Completion date is scheduled for July 31, 1972. Our application for sewer connection was submitted September 21, 1971. In the event that the application is not approved, we will design an alternate wastewater treatment plan which would be completed by June 30, 1973.

Very truly yours,

SOUTHERN WOOD PIEDMONT COMPANY

H I Warrington

H.I. Warrington,
Chief Engineer

HIW/pc

CC: Mr. J.C. Clark, Augusta Plant
Mr. C.A. Burdell, Atlanta

IC-6314

400-A

DU PONT
ESTABLISHED 1802

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE 19898

INDUSTRIAL CHEMICALS DEPARTMENT

March 15, 1972

RECEIVED
MAR 21 1972
GEORGIA
WATER QUALITY
CONTROL

Mr. R. S. Howard, Jr.
Executive Secretary
State Water Quality Control Board
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

Dear Mr. Howard:

Pursuant to your letter of March 7, 1972, we are submitting a brief status report as requested regarding the waste water abatement program at our Augusta Plant.

In view of the fact that the combined discharges from the Plant including both process waste water and cooling water is in the order of only five gallons per minute and contains innocuous quantities of sodium, sulfates, and silicates, we do not plan to present written or oral testimony at the conference.

Very truly yours,

A W Beasley/
A. W. Beasley
Plant Manager

AWB:slp

Enclosure

## AUGUSTA PLANT WASTE WATER ABATEMENT PROGRAM MARCH 1[illegible], 1972

The Augusta Plant manufactures sodium silicate. Waste waters from the process contain minor amounts of sodium silicate and suspended solids. The pH is alkaline from the presence of sodium silicate and sodium alkali salts used in the process.

The waste water abatement program at the Augusta Plant of the Du Pont Company includes equalization and settling, and effluent pH control that will soon be automated.

Construction of automatic pH control facilities is about 90% complete. All equipment has been installed and pH control instruments are now being placed in operation. We anticipate being able to switch to automatic control in about 60 days. In the meantime we are adjusting effluent pH manually. Sulfuric acid is being used to adjust pH and is responsible for the presence of sulfates in the discharge from the plant.

A retention pond for equalizing waste discharges and settling suspended solids is a part of our present abatement facilities.

During the next plant maintenance shutdown, now tentatively scheduled for May 1972, additional changes will be made to increase cooling water recycle. With this change we expect a 20% reduction in the cooling water discharged to the retention pond. Total effluent discharge from the plant is then expected to be less than 4 GPM.

We expect to complete our present active program items by mid-1972.

MR. WHITE: We will move right along now with the South Carolina presentation.

Mr. Tinsley.

MR. TINSLEY: Thank you, Mr. Chairman.

I would like to depart slightly and call first on Mr. Dave Heriot, who is a staff member of the Pollution Control Authority, to make the statement for the Authority.

JAMES D. HERIOT
CHIEF, COMPLIANCE BRANCH
WATER POLLUTION CONTROL DIVISION
SOUTH CAROLINA POLLUTION CONTROL AUTHORITY

MR. HERIOT: Mr. Chairman, conferees.

I am James D. Heriot, Chief of the Compliance Branch of the Water Pollution Control Division, South Carolina Pollution Control Authority.

I would like to summarize our report here, but I would like to suggest that the report itself be entered into the record.

MR. WHITE: Could we follow the same procedure we did in the case of Georgia and enter it in the official record and not reproduce it in the printed transcript?

MR. HERIOT: Yes, sir, I would suggest that the appendices, all supporting data, and so forth, be treated in that manner.

MR. WHITE: Fine. We will enter it into the record in that way.

(The above-mentioned document, marked Exhibit 3, is on file at the office of the Environmental Protection Agency, Region IV, Atlanta, Georgia.)

MR. HERIOT: For the sake of the record, I would like to point out two changes in this. On page 2 the date "April 1971" in reference to water classifications should read "September 1971," and on page 6 in the last line of the second paragraph "alkalinity" should read "pH."

The South Carolina Pollution Control Authority has addressed itself to that portion of the enforcement conference area as delineated on the map which is enclosed in the report and this includes portions of Edgefield County, Aiken County, Barnwell County and Allendale County in the State of South Carolina.

Considerable attention has been given to those areas within the confines of the conference area that represent the major problem areas confronting the State of South Carolina in the middle reach of the Savannah River. In this context the city of North Augusta, the city of Aiken and the industrial and municipal complex known as the Horse Creek Valley have received our major attention. In this area there are approximately 15 industrial dischargers and 5 municipal dischargers. The total industrial waste approximates 18 million gallons per day and the quantity of municipal waste about 2-1/4 million gallons per day. In addition there are a number of subdivisions and small invididual waste treatment facilities.

I think it is important to point out here that in the development of a comprehensive plan for this area there are also a total of 13 small municipalities, water and sewer districts that must be considered.

The geographical area has quite a high population. It is an industrial complex and with all of these various water districts, and so forth, it is extremely difficult to treat these interrelated problems individually.

I have included here in the report the water classifications for all of the streams that are represented in the area, and since they are a matter of record I will not go through those in detail unless questions should arise on those.

MR. WHITE: I believe Mr. Traina has a question.

MR. TRAINA: Just for the record, these three streams, I think there are three, on the AEC property, are those included in this classification, sir? That question came up earlier.

MR. HERIOT: They are shown on here and the classification is so indicated, Class B. And as was pointed out earlier this morning, that is based upon the fact that that portion of the Savannah River that they are tributary to is Class B.

MR. TRAINA: The Authority has in fact classified those three streams Class B?

MR. HERIOT: Not in their own right, but only in that they go into a Class B stream.

MR. WHITE: Could I ask, is that statement specifically in your standards?

MR. HERIOT: Yes. And a copy of the standards is attached as an appendices to this report.

MR. WHITE: This raises a question we are likely not going to resolve here, about the legality of that without specifically identifying it and possibly holding hearings on it, but I think we can possibly get into this a little later, I don't know, and we might not even resolve it in the executive session, but this does raise a question in my mind about precisely what has been done.

Mr. Tinsley?

MR. TINSLEY: I might point out that the water classification standards system under which we operate has been approved by EPA, Mr. Ruckelshaus approved it December 23 this past year, and that statement is included in the water classification standards system.

MR. WHITE: I am aware of that and hopefully there are no problems with it, but still I can see some arguments arising over this because--well, everything that is submitted and often approved is not perfection, as we all know.

Please proceed.

MR. HERIOT: On the point source discharges in this area under municipal, the city of Aiken, which was fairly well discussed this morning, has a waste treatment facility with a rating capacity of 1 million gallons per day. It has the capability to provide disinfection by means of chlorine contact. Currently this plant is giving a BOD reduction of from 65 to 75 percent. Effluent from this facility is discharged into Wilkerson Creek and from there into Horse Creek.

Also in the Horse Creek area there are three communities, Bath, Langley and Clearwater, who from a practical standpoint are discharging untreated wastes. There is a small facility there that consists of a comminutor and a chlorinator, but these unfortunately are inoperative.

The city of North Augusta, again this was pretty well covered this morning by the Mayor of the city, so I will not go into details on that other than to confirm the fact that they are under order from the Pollution Control Authority with a compliance date of April 15, 1972, and it is fairly obvious at this point that that date will not be met.

The industrial dischargers. The Gregg industrial waste treatment plant is an aerated lagoon constructed through the initiative of the Graniteville Company for treating both domestic and industrial wastes from its divisions of the nearby communities. This facility has a design capacity of 6.5 MGD and discharges into Horse Creek. The BOD reduction at present is approximately 50 percent. This is less than the design criteria anticipation. However, studies are under way jointly by the Graniteville Corporation and the technical staff of the Pollution Control Authority to try to determine the cause and try to come up with procedures that will improve the operation of this plant.

The Warrenville sewage treatment plant is an activated sludge facility providing treatment for the remaining divisions of the Graniteville Company, the town of Warrenville and a portion of Graniteville. The only industrial waste going into this facility is dye wastes from the Warren Division of the Graniteville Company. This sewage treatment plant also is producing a BOD reduction of about 50 percent and discharges approximately a half million gallons per day into Wilkerson Creek and thence into Horse Creek. This facility is also being included in the study being conducted jointly by Graniteville Corporation and the Pollution Control Authority to try to improve the quality of the operation of this plant.

The Graniteville Company of Graniteville, South Carolina, operates eight manufacturing divisions located in the Graniteville, Vaucluse, and Warrenville areas and these divisions discharge all domestic and industrial wastes to the Gregg industrial waste treatment plant that I previously mentioned and to the Warrenville sewage treatment plant. The Gregg, Granite, Woodhead, Hickman and Vaucluse divisions discharge small quantities of slasher starch wastes into Horse Creek, and the Warren division uses the Wilkerson Creek as a receiving stream for its slasher waste.

United Merchants and Manufacturers, Inc., owns four manufacturing plants located in the Langley, Bath, and Clearwater area, all of which discharge untreated waste into the streams in the area. Valchem at Langley and the Bath mill at Bath each discharge approximately 180,000 gallons per day of industrial and domestic waste to Horse Creek. Clearwater Finishing Plant at Clearwater discharges approximately 5 million gallons per day into Little Horse Creek. The adjacent Seminole

J. D. Heriot

Mill discharges 70,000 gallons per day into Little Horse Creek.

Downstream on the Savannah River in the vicinity of Beech Island is a Kimberly Clark plant which discharges approximately 5.2 million gallons per day of treated wastes into Dead River. Treatment is provided by a series of lagoons which is achieving approximately 85 percent BOD reduction. We also had a discussion this morning of the facilities at the Savannah River plant, so I will not go into those.

J. P. Stevens in Allendale County has recently completed construction of an aerated lagoon which has a design capacity of 500,000 gallons per day. The Pollution Control Authority authorized this facility be placed into operation in February of 1972. At this time we can't make any statements as to the efficiency of this plant, but we have every reason to believe that it will provide the treatment for which it was designed.

Other than these waste treatment facilities that I have mentioned by name, there are also a number of small subdivisions, privately-operated waste treatment plants in the area. Of course in addition to your point sources of discharge, there are a number of nonpoint sources. There are in all probability agricultural wastes through runoff going into the streams in the area, and then septic tanks play a major role in the treatment of domestic wastes in the area of the study. The more concentrated areas by water districts which are served by septic tanks are listed in the report and I will not read these off unless it is desired.

Our evaluation of the waters in the area is supported by Appendix A, which is included in the appendices of the report. This indicates that the quality of water in the Savannah River is in basic compliance with the standards of South Carolina, with the exception of the high fecal coliform densities and the presence of chromium in the sediments in the vicinity of the junction of Horse Creek with the Savannah River. Condition of the river here or in the study area is related to the discharge of the untreated wastes from the city of North Augusta and the wastes contributed from Horse Creek going into the Savannah River.

We can conclude that Horse Creek from the point closest to the Graniteville Corporation water treatment works to the Savannah River does not meet the water quality standards prescribed for it under the water classification standard system for the State of South Carolina. pH and fecal coliform densities exceed the allowable limits established by the standards and also increases in BOD are noted as you go downstream from the water plant at Graniteville until you reach the Savannah River.

The presence of chromium in Horse Creek is indicated by the evaluation of the data. An analysis of the effluent from the Gregg industrial waste treatment plant and the Valchem Chemical Company indicate that these are the two most probable sources of chromium contributions. High chromium concentrations in the effluent from the Gregg industrial plant indicated in the Environmental Protection Agency's study were not verified by recent PCA analysis. This is probably due to the fact that the Gregg industrial waste treatment plant, which receives wastes from the Gregg Division, went into operation after the field survey was performed by the Environmental Protection Agency.

High pH levels appear to be due to the industrial wastes from the divisions of the Graniteville Company and from the United Merchants Manufacturing Company. Excessive fecal coliform densities appear to be due to the absence of disinfection at existing waste treatment facilities and the absence of treatment of any type at other outfalls as referred to at other places in this report.

Comparisons of the data collected on Lower Three Runs above and below the discharge from the J. P. Stevens Company waste treatment facility indicate a decided increase in the BOD level of the stream and a decided reduction in the dissolved oxygen content of the stream. I must point out here, though, that these were all prior to--the data all prior to the time that this plant recently went into operation.

Included in the report is a map showing all of the sample stations that we used in preparing this report and they are listed and described in the report.

Enforcement and/or compliance. Realizing the adverse effect that the waste discharges were having on the streams in the study area, the South Carolina Pollution Control Authority several years ago initiated action to remedy the situation.

In March of 1970 a public hearing was conducted concerning the pollution of Mill Creek and Lower Three Runs Creek by the waste discharged from the J. P. Stevens Company. As a result of this hearing, J. P. Stevens Company was issued an order and with a compliance date of March 23, 1971, this was later extended to December 31, 1971, and as I stated earlier this plant went into operation in February of 1972.

On April 15, 1970, a public hearing was conducted to consider the pollution of the Savannah River by the discharge of untreated wastes into the river by the city of North Augusta. This resulted in an order being issued with a compliance date for completion of a waste treatment facility of April 15, 1972, and this was discussed in quite some detail this morning.

Also on April 15, 1970, a public hearing was conducted to consider the pollution of Little Horse Creek by the discharge of wastes from the Clearwater Finishing Plant, United Merchants and Manufacturers, Inc., Clearwater, South Carolina. As a result of this hearing, United Merchants and Manufacturers was ordered to construct and operate a waste treatment facility by April 15, 1973. By agreement between the United Merchants and Manufacturers, Inc., and the Pollution Control Authority, this facility is to also serve in addition to the--or is to serve the Clearwater Finishing Plant, the Seminole Mill, the Bath Mill, the Valchem Chemical Company, and also the communities of Bath, Langley, and Clearwater. Construction has started on this facility and it appears that it will be operational by the compliance date specified in the order.

The Graniteville Company, which consists of eight divisions, constructed the plant that we have referred to as the Gregg industrial waste treatment plant in 1969. This facility was to provide treatment for the industrial wastes from its textile mills and the domestic wastes from the communities of Graniteville and Warrenville which could not be handled by the previously constructed facility at Warrenville.

The Gregg industrial waste treatment plant was constructed at Graniteville and receives the industrial waste from the Gregg, Swint, Townsend, Hickman, Granite and Vaucluse divisions and 50 percent of the domestic wastes of the Gregg Division and the community of Graniteville and all of the domestic waste from the Townsend Division.

The Warrenville sewage treatment plant is an activated sludge plant which was constructed about 20 years ago. This facility receives the indigo dye waste from the Warren Division, the domestic wastes from the Warren village, 50 percent of the domestic waste from the Graniteville village, the domestic wastes from the Warren Division, the Hickman Division, the Woodhead Division and Gregg Division of the Graniteville Division. As I mentioned earlier, these two plants are not achieving the desired BOD reduction, but studies are under way to try to determine the cause and come up with remedies.

In addition to the actions enumerated above, the city of Aiken has determined that a need exists to increase the capacity of its plant from 1 million gallons per day to 3 million gallons per day. Realizing the load that this would add to Wilkerson Creek and Horse Creek and considering the interrelated problems of the area as a whole, the Pollution Control Authority conducted a meeting in Aiken on February 25, 1972, to encourage all interested governmental entities represented in the area to coordinate their efforts and develop plans for waste treatment facilities which would be mutually supported. Planning activities in this area are being conducted by the Lower Savannah Regional Planning and Development Commission.

Completion of those facilities now under construction or in various planning stages will clear up the major pollution problem in the area. And with the emphasis that has been placed on generating local action for a regional approach toward further development in this area, we feel that the water quality of streams in this area and, therefore, the water quality of the Savannah River will be greatly improved.

Mr. Chairman, this completes the presentation.

MR. WHITE: Thank you, sir.

MR. TINSLEY: Thank you, Dave.

So that we can clear this question that came up with respect to stream standards on specific streams, if you will go back to page 2 of the report you will note that there are specific streams that have been classified there, including the Savannah, Horse Creek, Little Horse Creek, Wilkerson Creek, and the only streams that are in this gray area that you mentioned, Mr. Chairman, would be the Kelly Creek, Upper Three Runs, Four Mile, Pen Branch and Lower Three Runs. This shows up on pages 2 and 3 of the report.

MR. WHITE: Thank you, Mr. Tinsley.

MR. TINSLEY: One other point I would like to make, that the classifications that are shown here are the result of hearings that were held quite a number of years ago and practically all of the streams that are mentioned in the report are scheduled for reclassification hearings.

What is the date of that hearing, Dave?

MR. HERIOT: March 30.

MR. TINSLEY: The 30th of this month in Greenwood. That is also in that section that was skimmed.

MR. WHITE: Anything further?

MR. TINSLEY: Any questions you might have?

MR. WHITE: This Lower Savannah Regional Planning and Development Commission, under what authority does it operate and where is it located?

MR. TINSLEY: Mr. Hollis can probably better answer that than either Dave or myself.

MR. WHITE: Fine.

MR. HOLLIS: The Lower Savannah Regional Development and Planning Council has its offices in Aiken, South Carolina, and it includes the several counties that are contiguous to Aiken and includes all of the area involved on the South Carolina side of the study. It was initially established by executive order of the Governor of South Carolina, subsequently has been designated as a Council of Governments under a recent law passed by the General Assembly, it has been accepted as the area planning organization by all interested Federal Agencies.

MR. WHITE: What implementation authority do they have?

MR. HOLLIS: They have only a planning and development responsibility. Implementation must be done by either a city, a county, or a public service district or by a private industry.

MR. WHITE: This is an advisory body with respect to the planning that they would be doing or are doing, right?

MR. HOLLIS: It is more than advisory. It is the planning and development, and upon completion of a plan, provided that the local government bodies accepted the plan, then it would have that function. But I would like to emphasize that it is the agency that has been designated by the State of South Carolina to do the regional and metropolitan planning under Title 18, CFR.

MR. WHITE: Let me change directions just a bit.

Has any conceptual plan been set forth as to how this regional system would operate at all? I mean has anything been presented on that?

MR. HOLLIS: Only preliminary conceptual aspects plus some earlier study. There does exist on the books the Valley Public Service Authority, a legally-authorized public service district chartered under the laws of South Carolina, which does have, at least on paper, both from the standpoint of implementation as well as planning, all of the powers of other public entities to include certain taxing, etc., provided, however, there are certain exclusion areas of those public entities within it which it could not preempt. This Authority exists and hopefully would have been the agency that would have established a regional system in here, but for various reasons it never did really come to fruition. It has been the intent to include the members of the county delegation and the mayors and others to look into and see what best can be done.

MR. LEDBETTER: Mr. Chairman.

MR. WHITE: Yes.

MR. LEDBETTER: I would like to try to get some clarification as to the relation of the Lower Savannah Regional Planning and Development Commission to the Richmond-Aiken Planning Commission.

MR. WHITE: Mr. Hollis.

MR. HOLLIS: To the Richland-Aiken, you say?

MR. LEDBETTER: Richmond-Aiken.

MR. HOLLIS: Richmond-Aiken.

MR. TRAINA: There is a metropolitan Council of Governments of Aiken and Richmond Counties, I believe is what you are referring to.

MR. HOLLIS: I believe that I am correct in this, that the Lower Savannah Regional Planning and Development Council occupies, insofar as the SMSA of this area is concerned, the same position as the agency that you spoke of.

MR. TRAINA: Has this group been certified by HUD?

MR. HOLLIS: It has been.

MR. TRAINA: We will just have to check this out. My information indicates that the Metropolitan Council of Governments of Aiken-Richmond County has been certified by HUD to do water and sewer planning and under our agreements with HUD we then accept them to do water quality management planning.

MR. HOLLIS: Paul, you may be right. There is an Upper Savannah and a Lower Savannah and I suspect that maybe I have given you false information there.

MR. TRAINA: Just for the record, my information indicates the Metropolitan Council of Governments of Aiken and Richmond Counties is the certified agency that HUD and EPA look to for water quality management planning under 18 CFR 601.

MR. HOLLIS: However, this is a gray area, I must admit, but that aspect of it on the South Carolina side would be done by the Lower Savannah Regional Development and Planning Council, so I would stick with that aspect of it. It is quite likely that it would have to be within the framework of the cog which covers the SMSA.

MR. WHITE: As I understand it, if you did have a regional collection system, Aiken would be a key cog in this thing, is the way the discussion has developed today. Is this correct?

MR. HOLLIS: Well, now, this is possibly so. I think it would be unwise to make a judgment on this without an engineering study which would really say this. I would respond in this respect, that Aiken discharges at the headwaters of very small streams and the low flow problem is extremely difficult. It would appear on cursory inspection that one alternative to Aiken's discharge might be to be piped further downstream and to be treated in an area that takes care of not only Aiken but also some of the other communities and industries in the area that do not yet have such treatment.

MR. WHITE: I notice a number of--I think we have one speaker yet to come representing the Graniteville Company, but I notice that none of the other--I mean no other dischargers are represented here. All of them were notified of the hearing, were they not?

MR. TINSLEY: Yes, very definitely. I have a list of all of the invitees and there are possibly others that we do not have names that would like to make statements.

MR. WHITE: Well, of course, I mean this is one of the things that the conferees really have to grope with, I mean as to how to get a handle on this and how to proceed.

MR. TINSLEY: Mr. Chairman, Mr. Thompson is here, who represents United Merchants and the Valley Public Service Authority. And I do hope that you have a statement that you would like to make.

If you would like, we can finish up with Mr. Heriot with questions and answers of him and then proceed. It may bring some of these other problems into focus.

MR. WHITE: Suits me.

Are there comments or questions? Mr. Howard.

MR. HOWARD: I wanted to ask something about nonpoint sources of wastes on page 8. I assume when you are talking about nonpoint sources of waste you are talking about a conventional closed system septic tank or are you just talking about a septic tank with a discharge or malfunctioning septic tanks?

MR. HERIOT: This would be any wastes that would come from these septic tanks through seepage, malfunctioning, and so forth.

MR. HOWARD: Largely malfunctioning septic tanks for some reason or other?

MR. HERIOT: Yes.

MR. HOWARD: What are the agricultural wastes referred to there? Is that feedlots and things like that?

MR. HERIOT: This is only the runoff from agricultural areas, feedlots, the contamination that may come out of pastures.

MR. HOWARD: Thank you.

MR. WHITE: Mr. Traina.

Excuse me, Mr. Tinsley.

MR. TINSLEY: On this septic tank, one of the specific reasons for our including this information is that if this area is to be sewered and facilities are to be installed they are potential customers, and I think we are shortsighted not to recognize that and this is the reason they were included.

MR. WHITE: Mr. Traina.

MR. TRAINA: Bear with me. I have a number of questions. I don't want to be out of character, so I will ask a number of questions.

With regard to the Stevens plant, what degree of treatment is going to be provided? You indicated that they are just going on line, but what are they designed for in terms of percent reductions?

MR. HERIOT: Eighty-five percent.

MR. TRAINA: Eighty-five percent. On the question of nonpoint sources, Mr. Little earlier this morning talked about some kaolin operations. Are you familiar with this? Do you have any information to provide on that?

MR. HERIOT: I don't have any information that--I can't speak with any degree of authority on that. I know that there is a kaolin mine over in that area, but specifically where it is I can't say.

MR. TRAINA: Mr. Rock Howard, I am sure, could talk about the problems of kaolin mining. He has faced them.

MR. HOWARD: Oh, we are the greatest in the world.

(Laughter.)

MR. TRAINA: I think that is a particular thing that needs to be investigated and try to tie that down.

MR. HERIOT: To the best of my knowledge, they do have a sediment pond, but I think that that is all that they have.

MR. TRAINA: I see.

On this thing of septic tanks, I did just quickly add up the population served by individual septic tanks and there are some 17,000 people, according to the figures in the report. That is a significant amount. Have you observed any effects on the water quality by that?

MR. HERIOT: Nothing that we can pinpoint.

MR. TRAINA: Is it your thought, or maybe Mr. Tinsley, is this going to be included in some sort of study series with the thought to incorporate the septic tank areas in sewage collection?

MR. TINSLEY: As I pointed out just a moment ago, we included those in that if that area is sewered they are potential customers. In the design of a facility, I think we should recognize that is a possibility.

MR. HOLLIS: I think also what Mr. Traina is raising here is that there are a number of communities in between Aiken and North Augusta only one of which is an incorporated community and the problem of implementation, enforcement, etc., is not only difficult insofar as individual septic tanks are concerned but also, with the exception of the public service district aspect of it, it is a question of to whom do you issue an order in an unincorporated community, not incorporated community.

MR. TRAINA: On the Gregg plant, apparently they are removing chromium now in that treatment facility?

MR. HERIOT: It appears that there is some reduction there.

MR. TRAINA: I take it it is some sort of an exchange, chromium is settled out and is removed from sludge, is that--how do they in fact get rid of the chromium there, do you know?

MR. HERIOT: I--Ken, can you--

MR. TRAINA: Frankly my question is, what happens to the sludge? If a sewer comes out in sludge what happens to the sludge, does anybody know? You know, the chromium thing, as the Federal report indicated, was rather, I think, significant amounts in the bottom materials.

MR. HERIOT: Our data shows that there is still some left and that there is still some being discharged, but it would appear from the sampling that we did recently that they are in fact getting a reduction. Now, whether or not this is a side benefit or intended, I think we would have to refer to somebody from the Gregg.

MR. TRAINA: Very frankly, again, one of the recommendations that we had earlier was for the immediate removal of any chromium discharges, and I am just wondering what are the industries going to do or have done in this regard.

MR. HERIOT: I can't respond to that, sir.

MR. HOWARD: Are the industries going to make a statement?

MR. TRAINA: Well, apparently not.

MR. WHITE: I think we have one--

MR. TRAINA: That is what I was just asking.

MR. WHITE: --representative, and I believe Mr.

Tinsley indicated someone else would make a statement.

MR. TINSLEY: Yes. I think some of these questions will be answered if we do progress.

MR. TRAINA: O. K. Then the other question was with regard to the United Merchants plant, will they in fact remove chromium from the industries that apparently are going to tie into that plant. That may be answered later?

MR. TINSLEY: Conceivably, yes. If it is not, we can always ask Mr. Heriot to come back.

MR. TRAINA: O. K.

Just one final comment and just to pick up the earlier discussion with regard to this regionalization situation. Frankly, I think the problem the conferees are going to face is we all recognize the need for regionalization in this Horse Creek Valley area, that recommendation was made to us already. The question is, Charlie, who do we direct an order against or an action against? And I think that is the real question. Is it the Lower Savannah Planning Commission, is it a COG area, the State of South Carolina?

MR. WHITE: That is something I think we need to explore a little more and that is what I wanted to do when Mr. Tinsley brought these other representatives on.

MR. HOWARD: Such a thing as unincorporated communities, and so forth?

MR. TRAINA: Yes. I mean there are a lot of these little areas there. Maybe this can't be answered now, but it is a question we are going to have to come out with, Dave, before we convene the executive session.

In deference to time I will defer any further questions.

MR. WHITE: I don't want to leave that because I think we have got to get back into the issue to get some clarification, but if you want to proceed, Mr. Tinsley.

MR. TINSLEY: I think it would be best to proceed to see what the others that are involved have to say in that we simply have presented the statement of the authority and the two major municipalities had an opportunity to present their statement this morning.

Let's next call Mr. Carl Williams with J. P. Stevens and Company.

## CARL WILLIAMS

MANAGER, DIVISIONAL ENGINEERING
J. P. STEVENS COMPANY
ALLENDALE, SOUTH CAROLINA

MR. WILLIAMS: Mr. Chairman, ladies and gentlemen.

I have made a few notes here I would like to pass on to this hearing.

I am Carl Williams, Manager of Divisional Engineering for J. P. Stevens Company, with responsibilities at Allendale.

Last year we constructed or started construction and placed in operation a waste treatment facility for the Allendale plant which is a wool scouring and top making operation. As a matter of information, to realize the pollution load we are operating under or with, 500 pounds of greased wool coming into this plant, we realize 250 pounds of end product. The rest is dirt, grease, and other pollutants.

This plant was designed on the basis of a grit removal system, aerated canal, clarifiers and sludge beds.

The plant was actually placed in operation early last fall, operated for a couple of months, and since, well, early December we had problems with the transmission equipment on the drives for the aerators. These drives have all been back to the manufacturer one time and one of them has actually been back twice. Needless to say, I would like to get rid of that headache, so I hope we are back in operation permanently now.

The early operation test data indicates that we will meet the design pollution standards. I don't think we have sufficient data at this time to make a report as to these findings, but based on the early operation and the operation since February I feel that we will have a system with which we will meet the present day standards.

That is all I have.

MR. WHITE: Thank you, Mr. Williams.

Comments or questions?

MR. TRAINA: I assume, sir, you meant 85 percent reduction?

MR. WILLIAMS: Yes.

MR. HOWARD: Do you have any pesticides or fungicides in that operation?

MR. WILLIAMS: Not at Allendale, there are none of the toxic elements there, except what could come in on the wool, you know, that we are buying there.

MR. WHITE: Thank you, Mr. Williams.

MR. TINSLEY: Next I would like to call Mr. William C. Lott of the Graniteville Company.

WILLIAM C. LOTT
VICE PRESIDENT - ADMINISTRATION
GRANITEVILLE COMPANY
GRANITEVILLE, SOUTH CAROLINA

MR. LOTT: Mr. Chairman, conferees, ladies and gentlement.

Since this conference concerns the middle Savannah River, and its tributaries and since Horse Creek is a tributary of the Savannah River and is the subject of a portion of the report prepared by the EPA, and since Graniteville Company and its activities are also the subject of comments in that report, we wish to file this statement with you gentlemen as a part of the official record of the conference. I will try to make it brief and I won't read everything that is in the written report because, frankly, some of it has been covered by others who preceded me.

MR. WHITE: We will accept your report in the record in toto as if read.

MR. LOTT: Thank you.

(The above-mentioned report follows:)

Graniteville, S. C.
March 22, 1972

# STATEMENT FILED BY GRANITEVILLE COMPANY AT ENFORCEMENT CONFERENCE CONDUCTED BY ENVIRONMENTAL PROTECTION AGENCY AT THE HOLIDAY INN, AUGUSTA, GEORGIA -- MARCH 22-24, 1972

This conference concerns the Middle Savannah River and its tributaries. Since Horse Creek is a tributary of the Savannah River and is the subject of a portion of the report prepared by the Environmental Protection Agency, and since Graniteville Company and its activities are also the subject of comments in that report, we wish to file this statement with the South Carolina Pollution Control Authority as a part of the official record of the conference.

As a matter of information, Graniteville Company's charter was issued by a Special Act of the South Carolina Legislature on December 15, 1845. As a manufacturer and finisher of cotton and blended fabrics since that time, the Company is now in its 127th year. It would be difficult for any corporation to grow and prosper over such a long period of time while ignoring its responsibilities as a good corporate citizen. William Gregg, founder of Graniteville, recognized these responsibilities as far back as 1848 when, in placing a notice in the Edgefield Advertiser for employees to start up the original Graniteville Mill, he said: "No person will be received into the service of the Company who cannot bring the best testimonials as to their moral character, and none will be permitted to remain in the place who do not maintain such character....Two churches are erected....School houses will be provided....All families in the employ of the Company, as well as residents of the place, will be required to keep constantly at school all children under the ages of thirteen." Thus, when he breathed the breath of life into our Company a century and a quarter ago, he made it plain that this Company would be one concerned with social and human values -- at the same time, he recognized the inescapable truth that unless the Company he had created turned in a profit it could accomplish none of its social objectives, for in the same advertisement he said: "It is the object of the Company to benefit the State by giving employment to the deserving poor, but it is also a primary object to obtain interest on the capital expended in these works and they will not permit their houses to be occupied by any who cannot or will not render themselves useful."

Throughout the succession of management since Gregg's day to the present, Graniteville has been concerned with human values as well as with the economic aspects of its business. Good churches, schools, homes, colleges and hospitals; safe and healthy working conditions; regular work at good wages and with a worthwhile benefit program over and above regular pay; equal opportunity for employment, for training and for advancement; wholesome recreation for young and old; turning out a quality product at a fair price -- these have always been fundamental corporate objectives of our Company.

In regard to our concern with pollution and the best use of our land and water resources, we submit the following facts:

A. The most serious form of water pollution, since it constitutes a health hazard, is raw sewage. In 1947 Graniteville Company constructed an activated sludge type sewerage treatment plant to handle the domestic waste from our plants and the homes in our Graniteville, Warrenville and Vaucluse communities. At the time this plant was built, it was recognized by municipal engineers and the State Health Department as one of the most modern and efficient plants of its type in the State. It was built, with additions and modifications which have been made, at a cost of over $400,000; additionally, the Company bears the annual operating cost, which is approximately $30,000. This action was taken by the Company on a purely voluntary basis years ago to assure that no raw sewage would be coming into Horse Creek from any of its plants or homes.

In the EPA report, our sewage plant is referred to as an "antiquated facility". We take issue with this description, since we have never before been the subject of any unfavorable report by local or state health authorities on the operation of the plant. We have spent considerable sums of money to keep the plant in first-class operating condition since it was built. We also take pride in the fact that it was the first and is still the only municipal sewage treatment plant in all of Horse Creek Valley, antiquated or not. Further, in connection with the operation of our industrial waste treatment plant, which will be described in the latter portion of this statement, we have reduced the treatment load on the Warrenville sewage plant by 325,000 gallons per day, which should improve the performance of this facility considerably. Also, since seeing the EPA report, we have entered into an agreement with Dr. John T. Porter, of Clemson University, to analyze the operation of this plant and advise us as to how it might be further improved -- this contract became effective on January 25, 1972.

Frankly, we were surprised to learn the facts brought out by the EPA study concerning this plant, particularly those with reference to the fecal coliform content of the discharge. We have gone to the expense of having these facts verified by an independent laboratory, and we expect to do whatever is necessary to see that the fecal coliform currently in this discharge is reduced to the standards which will be required under the State Pollution Control Authority's new classification requirements.

B. When the new Gregg Dye Plant was built in 1950, we took cognizance of the waste treatment problem and constructed the plant so that all the industrial wastes were collected in one tank where they were diluted prior to being poured into Horse Creek. In this manner sudden changes in temperature or drastic fluctuations in the PH content were minimized. We also arranged to pump all hot waste through heat exchangers to be cooled before discharge to the creek. Since caustic soda was our most serious source of pollution, we installed evaporators to concentrate and reuse our caustic soda.

In 1964, upon the recommendation of the late Mr. William Linton, Chairman of the South Carolina Water Pollution Control Authority, Graniteville Company employed the services of the nationally known engineering firm of Charles T. Main, Inc., Charlotte, North Carolina, and Boston, Massachusetts, to study the pollution problem created by industrial waste flowing from the Graniteville Company plants located in Graniteville, South Carolina and to recommend a satisfactory method of controlling this pollution within acceptable limits.

Charles T. Main, Inc. designed a system, prepared a report and presented it to the South Carolina Water Pollution Control Authority informing them of the work done for Graniteville Company on the waste water problems and the plans to solve these problems. On July 8, 1969 the South Carolina Pollution Control Authority issued Permit No. 1427 to Graniteville Company to construct a treatment system for sewage and textile finishing waste and a temporary permit to discharge after completion of all work pending final tests and inspection. The plant was designed as a bio-aeration system and put into operation in June of 1971 at an approximate cost of $830,000. Charles T. Main, Inc. stated that the system would produce a 90-95% reduction in BOD and a PH reduction from 12 to 9. These results have not yet been obtained and work is continuing. The operating cost of the system is approximately $100,000 per year. In a letter dated September 15, 1971 from Mr. H. A. Woodhead, Superintendent, Engineering Department of Graniteville Company, to the South Carolina Pollution Control Authority, we advised them that the industrial waste plant had been put into operation and that we welcomed their advice and assistance. In August 1971 the EPA reported 30,100 pounds per day of $BOD_5$ discharged from our Gregg Finishing Plant. Through the operation of our industrial waste treatment plant, this amount has now been reduced to 10,000 pounds per day or by slightly better than two-thirds. Our objective is a reduction of 85% of the BOD demand, and we expect to reach that objective with the assistance of the engineers who designed the plant, the South Carolina Pollution Control Authority, and other sources of assistance.

As just stated, our aerated lagoon treatment plant is not giving the BOD reduction desired. Our engineering consultants believe this is due to a deficiency of nutrients in combination with high hydroxyl alkalinity. To increase the nutrients to the level desired, we have just completed (March 14, 1972) 1,800 feet of 10" force main to pump sewerage from the south side of Graniteville to our lagoon pumping station. This will add 325,000 gallons per day of domestic sewerage to our lagoons, which should help raise the effectiveness of this plant as well as the Warrenville sewage plant, mentioned earlier. We are now in the process of connecting all starch waste lines to pump waste starch to our industrial waste treatment plant. Again, this is designed to increase the effectiveness of the industrial waste treatment plant as well as the Warrenville sewage plant. Finally, we are actively involved in work designed to reduce the alkalinity of the waste flowing from our Gregg Dyeing Plant to our industrial waste treatment plant -- in order words, a further improvement of the recycling of our caustic already mentioned. We have reason to believe that these efforts are going to prove successful and help to produce the operating results at our waste treatment plant which we set out to achieve when the plant was built (see attached memorandum dated March 17, 1972 from Mr. L. L. Johnston, Plant Engineer, Gregg Dyeing Division, to Mr. J. E. Bresnahan, Assistant Vice President in charge of Dyeing and Finishing).

Finally, the EPA study completed in August 1971 indicated that 865 pounds per day of chromium was being discharged from our Gregg Plant. An analysis conducted by the South Carolina Water Pollution Control Authority has since reported 548 pounds of chromium being discharged per day. Also, the EPA reported finding 990 mg/kg of chromium in the mud bottoms of Horse Creek. This report includes the statement, "No information on the effects of high levels of chromium in sludge deposits are available." The EPA recommends that Graniteville immediately eliminate chromium from its waste discharge.

Frankly, we do not feel that enough information is currently available concerning the discharge of chromium compounds to support the recommendation of the EPA. In the rather exhaustive preliminary studies made by Charles T. Main, Inc. before the design of our industrial waste treatment plant was approved, as well as the operation of the pilot plant run for the purpose of settling on this design, no mention was ever made of chromium as a "bad actor" and no particular attention was given to its elimination. To the best of our knowledge, the EPA report itself is the first time we have seen any mention of chromium as an undesirable element in our industrial waste. This does not mean that we are taking issue with the EPA on the question of whether or not chromium is actually the undersirable element that the report indicates. Chromium compounds are extremely important to our operations (see the attached report from Mr. Lewis S. Ready, Technical Superintendent, Gregg Division, dated February 23, 1972, with a later report dated March 14, 1972). As will be noted from this report, we utilize sodium bichromate to oxidize our vat and sulfur dyes. There are some 6,000 dye shades in which the formulation requires the use of an oxidizing agent to produce the quality standards demanded by our customers. Mr. Ready's report shows that since the EPA study became available to us we have been actively seeking suitable substitutes for chromium in the dyeing processes in which it is utilized. Up to this point, the most likely substitutes which we have tried have not produced satisfactory results. Nevertheless, we recognize the problem and we shall continue to seek its solution. We would like to point out that if no suitable substitute for chromium can be found, extensive in-plant machinery changes may be necessary to separate wastes containing chromium from other wastes and to successfully dispose of chromium wastes. This would require considerable time, estimated at some two years.

## GENERAL:

We would like to re-emphasize Graniteville Company's positive approach to the problem of abatement of pollution and improvement of the environment. We think the work that we have done and the rather large sums of money we have spent going back far beyond the time when this subject became such an important public issue is the best evidence we can present that we have every intention of doing our part in this national effort. We have always tried to be a good corporate citizen and we shall continue to do so. Unless those in public office adopt a practical, reasonable and cooperative approach to the solution of our environmental problems, and utilize the nation's resources to improve the welfare of all its citizens, we might well saddle business and industry with such staggering costs as to price its products out of an already highly competitive international market.

We certainly want to do everything we can to improve the quality of water in Horse Creek. We have already expended a great deal of time, energy and money in this effort. We think the record shows that we have done more work toward this goal than anyone else in Horse Creek Valley. We think that our 1971 payroll of $39,082,948, our total taxes of $6,378,468 and the jobs of the 5,853 people on the payroll at the year-end entitle us to consideration as an important factor in the economic health of the area under study in this conference. All we ask is that a fair and reasonable approach be made in considering the difficult problems that we face, and that recognition be given to the necessity for reasonable standards of quality and reasonable lengths of time to achieve the objectives that all of us want to obtain.

William C. Lott
Vice President - Administration

William C. Lott
mfa
Attachments

# OFFICE MEMO

Graniteville
COMPANY
GRANITEVILLE, SOUTH CAROLINA

TO: Mr. J. E. Bresnahan

DATE March 17, 1972

FROM: L. L. Johnston

SUBJECT:

COPIES:

Mr. Jerry Johnson ✓

As you know we have been working on reducing the amount of alkali in our effluent in order to improve the operation of the waste treatment plant.

The approach taken is in the form of a three point program, as follows:

1. Increase the efficiency of the evaporator by closer supervision of the evaporator itself and the wash system on the mercerizers.

2. Change the location of chlorine feed from the reclaim feed line to the evaporator to the fill line on the reclaim storage tanks. This allows time for settling of solids before evaporation and eliminates the dumping of 40% caustic "settlings" after evaporation.

3. Attempt to clean up and reuse the overflow caustic from the boilouts that is normally pumped to the waste treatment plant in the effluent from Gregg. In order to pursue this portion of the project, after preliminary work showed promise, a pump was installed and a three inch pipe was run from #3 & #4 B/O to the tank farm (593feet). Two fifteen thousand gallon tanks were temporarily diverted from mercerizer reclain caustic storage and we have been using them on a batch type basis for treating boilout caustic.

OFFICE
MEMO
Graniteville
COMPANY
GRANITEVILLE, SOUTH CAROLINA

TO: Mr. J. E. Bresnahan
DATE
FROM:
SUBJECT:
COPIES:

Page 2

Sodium Hypochlorite when added to the caustic bleaches out the color and causes a floc to form. Most of the floc will settle to the bottom of the tank within 24 to 36 hours and can be drawn off the cone shaped bottom of the tank. The remaining liquid about 75% can then be reused on the boilout. Initial experiments indicate that this is feasible but the cost of the Sodium Hypochlorite is such that it costs about as much as the caustic saved. We are now working with chlorine gas to try to reduce the cost. Our latest efforts indicate a usage of about $50 per day for chlorine gas will give good color removal and a satisfactory floc. We have also found that soapstone sprinkled on top of the treated caustic will weight the floc and make it drop to the bottom of the tank faster. Last week we reused 50,000 gallons of 4½% to 5% caustic recovered from the boilouts and have used another 50,000 gallons this week.

Caustic consumption at Gregg in the Preparation department has averaged 613,382 pounds per week this year for our six day weeks. Last week we used 562,531 pounds for a seven day week. This may be just an extraordinarily good week or it may be indicative of the results of the above work.

OFFICE
MEMO
Graniteville
COMPANY
GRANITEVILLE, SOUTH CAROLINA

TO: Mr. J. E. Bresnahan

FROM:

SUBJECT:

COPIES:

DATE

Page 3

I hope that we will be able to make a recommendation on the size and number of settling tanks and related equipment needed within another week or two.

Lawton Johnston (lw)
Plant Engineer

L. L. Johnston
lw

445

# INTER OFFICE MEMO

**Graniteville**
COMPANY
GRANITEVILLE, SOUTH CAROLINA

TO: Mr. Jerry Johnson

DATE February 23, 1972

FROM: Lewis S. Ready

SUBJECT: Chrome in Gregg Effluent

COPIES: Mr. J. E. Bresnahan

Hexavalent Chrome after Oxidizing process used it may be trivalent which will do no harm

Our source of chromium contaminant in the Gregg effluent is caused by Sodium Bichromate that we use to oxidize Vat and Sulfur dyes. We use from 2,000 to 3,000 pounds of Sodium Bichromate per day. In our efforts to obtain good oxidation of these dyestuffs, we use an excess amount of Bichromate. A conscientious program has been started to reduce the amount of chrome used on those shades where we have a known excess. For some time now we have been trying to find a chemical oxidant to replace all or at least part of the Sodium Bichromate. A considerable amount of plant work has been done using Hydrogen Peroxide, but this has proven very difficult to control. Several new items have been tested in our laboratory, and we are planning a plant trial on one of these February 29. We feel confident that this new product will prove successful on our Vat dyes and should not contribute to stream pollution.

L. S. Ready
Technical Superintendent

LSR/jb

OFFICE
MEMO
Graniteville
COMPANY
GRANITEVILLE, SOUTH CAROLINA

TO: Mr. J. E. Bresnahan

DATE March 14, 1972

FROM: Lewis S. Ready

SUBJECT: Oxitone Trial

COPIES: Mr. Harry Momeier
Mr. Jerry Johnson
Mr. Lester Boyd
Mr. Charles Bailey
Mr. Tom Tantillo

We have completed our evaluation of the Oxitone trial made February 29. The purpose of this trial was to find a substitute for Sodium Bichromate as an oxidizing agent in dyeing. The trial was made on Super Twill, Shade 1635, Lot 59-4903, 22,078 yards and Super Twill, Shade 989, Lot 59-4902, 27,300 yards. Shade 1635, Navy required a dye increase of approximately 15% and came up a little flat to the standard. Shade 989, Tan required a 10% increase in the Olive and Khaki dyestuffs and a 10% reduction in the Brown dye. This shade ran a little flat and yellow to the standard. Some problems were encountered in the titration of this chemical, but we now believe that this has been worked out so we can maintain a closer control in the oxidizing tubs. Another trial will be made next week to see if the closer control on this product will advance our efforts to find a non-polluting oxidant.

I have attached the plant trial report for your information.

Lewis S. Ready

LSR/jb

Attachment

DATE: 3-8-72

# PLANT TRIAL REPORT

DATE OF TRIAL: 2-29-72

STYLE: SUPER TWILL 989 SHADE LOT 59-4902

YARDS: 27,300

DEPARTMENT: DYEING

MACHINE: #4 DYE RANGE

PRODUCT: OXITONE

COMPANY: OLIN CHEMICAL

TECHNICIAN: TOM TANTILLO

RANGE SET-UP: SUBSTITUTED OXITONE IN THE THIRD TUB FOR CHROME & ACID

PROCEDURE: MAINTAIN 0.5-0.75 OPG OXITONE @ 180°.

PERTINENT INFORMATION:

HEAD MIX WAS A 17.76 OPG SOLUTION. MADE 550# OXITONE/500 GAL. WATER.
ALSO ADDED 10 GALS OF WET AID R.
USED 450 GALS OF OXITONE FOR THIS RUN.
TITRATION AVERAGE 5.2 OPG OXITONE
TUB TEMP. 180°.
@ 3:14 AM 2-29-72 HEAD MIX TITRATED 13.4 OPG PH-9
@9:15 AM 3-1-72 HEAD MIX TITRATED 8.6 OPG PH-9
@ 11:45 AM 3-2-72 HEAD MIX TITRATED 4.1 OPG PH-9.6

CONCLUSION:

HAD TO INCREASE THE OLIVE AND KAKI 10%
BUT REDUCED THE BROWN 10% IN THE DYE FORMULAR
SHADE A LITTLE FLAT AND YELLOW TO STD.
CLOTH PH-8.0

TITRATION PROCEDURE UNCERTAIN. NO REPRODUCTIBLE RESULTS.
DID NOT SEE ANY NOTICIABLE CHANGE IN LABORATORY TESTING OXITONE VS. CHROME

MR. LOTT: As a matter of information, and it doesn't really prove anything, I would like to say that Graniteville Company's charter was issued by a special act of the South Carolina Legislature on December 15, 1945. As a manufacturer and finisher of cotton and blended fabrics since that time, the company is now in its 127th year. It would be difficult for any corporation to grow and prosper over such a long period of time while ignoring its responsibilities as a good corporate citizen.

William Gregg, founder of Graniteville, recognized these responsibilities as far back as 1848, when, in placing a notice in the Edgefield Advertiser for employees to start up the original Graniteville mill, he said this:

> No person will be received into the service of the company who cannot bring the best testimonials as to their moral character.

Some of us there now may be pretty happy that that is no longer necessarily true. (Laughter.)

> Two churches are erected. School houses will be provided. All families in the employ of the company, as well as residents of the place, will be required to keep constantly at school all children under the ages of 13.

Now, this was before any public school system was ever established in the State of South Carolina.

My point is this, that when Gregg breathed the breath of life into our company a century and a quarter ago, he made it plain that this company would be one concerned with social and human values. At the same time he recognized the inescapable truth that unless the company he had created turned in a profit, it could accomplish none of its social objectives, for in the same advertisement he said this:

> It is the object of the company to benefit the State by giving employment to the deserving poor, but it is also a primary object to obtain interest on the capital expended in these works and they will not permit their houses to be occupied by any who cannot or will not render themselves useful.

Throughout the succession of management since that time, we have been concerned with human values as well as with the economic aspects of our business.

To bring us down to the point which we are discussing here, and in regard to our concern with pollution and the best use of our land and water resources, we would like to submit the following facts:

W. C. Lott

First, the most serious form of water pollution, since it constitutes a health hazard, is raw sewage. Back in 1947 Graniteville Company constructed an activated sludge-type sewage treatment plant to handle the domestic waste from our plants and the homes in our Graniteville, Warrenville, and Vaucluse communities. At the time this plant was built, it was recognized by municipal engineers and the State Health Department as one of the most modern and efficient plants of its type in the State. It was built, with additions and modifications which have been made since, at a cost of over $400,000. Additionally, the company bears the annual operating cost, which is approximately $30,000. This action was taken by the company on a purely voluntary basis years ago to assure that no raw sewage would be coming into Horse Creek from any of its plants or homes.

In the EPA report, our plant is referred to as an "antiquated facility." We take issue with this description, since we have never before been the subject of any unfavorable report by local or State health authorities on the operation of the plant. We have spent considerable sums of money to keep it in first-class operating condition since it was built. We also take pride in the fact that it was the first and is still the only municipal sewage treatment plant in all of Horse Creek

Valley, antiquated or not.

Further, in connection with the operation of our industrial waste treatment plant, which will be described in the later portion of this statement, we have reduced the treatment load on the Warrenville sewage plant by 325,000 gallons per day since that report was made, which should improve the performance of this facility considerably.

Also since seeing the EPA report, we have entered into an agreement with Dr. John T. Porter, of Clemson University, to analyze the operation of this plant and advise us as to how it might be further improved. This contract became effective on January 25, 1972.

Frankly, we were surprised to learn the facts brought out by the EPA study concerning this plant, particularly those with reference to the fecal coliform content of the discharge. We have gone to the expense of having these facts verified by an independent laboratory, and we intend to do whatever is necessary to see that the fecal coliform currently in this discharge is reduced to the standards which will be required under the State Pollution Control Authority's new classification requirements which will become effective on the 30th of this month. I don't know that they will become effective, but the hearings will be held on the 30th of this month.

Incidentally, in the lab report which verified the fecal coliform figures, there was no verification of Salmonella. In other words, the EPA report, I believe, showed Salmonella, whereas Ken Back's report showed no Salmonella.

Second point. When the new Gregg dye plant was built in 1950, we took cognizance of the waste treatment problem and constructed the plant so that all the industrial wastes were collected in one tank where they were diluted prior to being poured into Horse Creek. In this manner, sudden changes in temperature or drastic fluctuations in the pH content were minimized. We also arranged to pump all hot wastes through heat exchangers to be cooled before discharge to the creek. Since caustic soda was our most serious source of pollution, we installed evaporators to concentrate and reuse our caustic soda.

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On July 8, 1969, the South Carolina Pollution Control Authority issued Permit No. 1427 to Graniteville Company to construct a treatment system for sewage and textile finishing waste and a temporary permit to discharge after completion of all work pending final tests and inspection.

The plant was designed as a bioaeration system and put into operation in June of 1971 at an approximate cost of $830,000. Charles T. Main stated that the system would produce a 90 to 95 percent reduction in BOD and a pH reduction from 12 to 9. These results have not yet been obtained and work is continuing. To say that we are disappointed in that would be quite an understatement.

The operating cost of the system is approximately $100,000 a year. In a letter dated September 15, 1971, from Mr. H. A. Woodhead, Superintendent, Engineering Department of our company, to the South Carolina Pollution Control Authority, we advised them that the industrial waste plant had been put into operation and that we welcomed their advice and assistance.

In August 1971 the EPA reported 30,100 pounds per day of $BOD_5$ discharged from our Gregg Finishing plant. Through the operation of our industrial waste treatment plant, this amount has now been reduced to 10,000 pounds per day or by slightly better than 2/3. Our objective is a reduction of 85 percent of the BOD demand, and we expect to reach that objective, with the assistance of the engineers who designed the plant, the South Carolina Pollution Control Authority, and other sources of assistance.

As we have just stated, our aerated lagoon treatment plant is not giving the BOD reduction desired. Our engineering consultants believe this is due to a deficiency of nutrients in combination with high hydroxyl alkalinity. To increase the nutrients to the level desired, we have just completed, on March 14 of this year, 1,800 feet of 10-inch force main to pump sewage from the south side of Graniteville to our lagoon pumping station. This will add 325,000 gallons per day of domestic sewage to our lagoons, which should help raise the effectiveness of this plant and at the same time raise the effectiveness of the Warrenville sewage plant mentioned earlier.

We are now in the process of connecting all starch waste lines to pump waste starch to this industrial treatment plant. Again this is designed to increase the effectiveness of the industrial waste treatment plant and to increase the effectiveness of the sewerage plant.

Finally, we are actively involved in work designed to reduce the alkalinity of the waste flowing from our Gregg dyeing plant to our industrial waste treatment plant--in other words, a further improvement of the recycling of our caustic already mentioned. We have reason to believe that these efforts are going to prove successful and help to produce the operating results at our waste treatment plant which we set out to achieve when the plant was built. And I have attached a memorandum from my technical staff indicating the technical aspects of that work.

Finally I come to a point which has been talked about earlier and with which we are greatly concerned and that is the chromium. The EPA study completed in August of 1971 indicated that 865 pounds per day of chromium was being discharged from our Gregg plant. An analysis conducted by the South Carolina Water Pollution Control Authority since has reported 548 pounds of chromium being discharged per day. Also, the EPA reported finding 980 mg/kg of chromium in the mud bottoms of Horse Creek. This report includes this statement, quote:

> No information on the effects of high levels of chromium in sludge deposits are available.

W. C. Lott

The EPA recommends that Graniteville immediately eliminate chromium from its waste discharge.

Frankly, we do not feel that enough information is currently available concerning the discharge of chromium compounds to support the recommendations of the EPA. In the rather exhaustive preliminary studies made by Charles T. Main before the design of our industrial waste treatment plant was approved, as well as during the operation of the pilot plant run for the purpose of settling on this design, no mention was ever made of chromium as a bad actor and no particular attention was given to its elimination.

To the best of our knowledge, the EPA report itself is the first time we have seen any mention of chromium as an undesirable element in our industrial waste. This does not mean that we are taking issue with the EPA on the question of whether or not chromium is actually the undesirable element that the report indicates. Chromium compounds are extremely important to our operations. And I have attached a report to indicate that also, Mr. Chairman.

As will be noted from this report, we utilize sodium bichromate to oxidize all of our vat and sulfur dyes. There are some 6,000 dye shades in which the formulation requires the use of an oxidizing agent to produce the quality standards demanded by our customers. Mr. Ready's report shows that since the EPA study became available--and incidentally, this was, as I recall it, toward the latter part of last year--we have been actively seeking suitable substitutes for chromium in the dyeing processes in which it is utilized. Up to this point, the most likely substitutes which we have tried have not produced satisfactory reults.

Nevertheless, we recognize the problem and we shall continue to seek its solution. We would like to point out that if no suitable substitute for chromium can be found, extensive in-plant machinery changes may be necessary to separate wastes containing chromium from other wastes and to successfully dispose of the chromium wastes. This would require considerable time, possibly as much as two years.

Finally, we would like to reemphasize our company's positive approach to the problem of abatement of pollution and improvement of the environment. We think the work we have done and the rather large sum of money we have spent going back far beyond the time when this subject became such an important issue is the best evidence we can present that we have every intention of doing our part now. We have always tried to be a good corporate citizen and we shall continue to do so.

However--and I am not going to read the remainder of this; I merely want to make this point as a businessman--that annual report, which is over there and has just come out from last year, shows that our profit on sales last year amounted to 2.8 percent, that is net profit after taxes. That is not much margin to work with. You heard the gentleman from Augusta, Mr. Beckum, talk about needing some money to build his plant. You heard Mr. Walters of North Augusta and you have heard others talk about increasing the Federal formula for allotments for public works, projects of this sort. We all know that it is going to take a lot of money to do this job. Where is that money coming from?

I read a statement not long ago by Mr. Willard Rockwell in which he said that economists had indicated that 1 million new persons would be needing to find jobs in the American economy every year for the next 20 years. Where are those jobs coming from?

Gentlemen, somewhere along the way we have got to arrive at a compatible approach and a practical approach to this problem. We want to do our part. We expect to be a good corporate citizen. But if we don't make enough money to pay the taxes that we have been paying, to keep our people employed so they can pay their income taxes, and many thousands and hundreds of thousands of industries and businesses throughout this country, then the gentlemen who are sitting here and conducting these hearings are not going to have any pay checks and we are not going to be, really, interested in conducting these hearings.

There must be somewhere along the way a practical approach to this problem.

Thank you.

MR. WHITE: Thank you, Mr. Lott. Let me assure you, it is not the intention of the conferees, I am sure, to try to put anyone out of business, but we are here seeing how we can go about and best correct the pollution problems that we do have.

MR. LOTT: I wouldn't want to give anybody the impression that I think that.

MR. WHITE: Fine.

MR. LOTT: But I do think that there must be a practical approach.

MR. WHITE: Well, we certainly hope so and maybe we can find it. But let me ask you--

MR. LOTT: The chromium question is a good example of what I am talking about because, frankly, until recent months we were apparently operating in the dark as far as chromium is concerned and yet it is an important element in our process.

MR. WHITE: Right. I understand that concern.

But I want to ask you a question that is possibly a little unfair; I don't know whether you can answer it or not. But I think you heard the recommendation that was made earlier in the Federal report about a collection system in a central waste facility.

MR. LOTT: Yes, I have heard that.

MR. WHITE: What are your thoughts on this? Do you think the company would voluntarily go along with such an undertaking?

MR. LOTT: I will answer you this way. When the idea first came up, and this was several years ago, I think--did you say Mr. Thompson was here?

MR. TINSLEY: Yes.

MR. LOTT: He can tell you more about this than I can.

We were approached on this question and at that point we did not consider that it was necessary for us to enter into that regional or joint type of planning or approach simply because we felt that we had already done the type job that was becoming necessary to be done on the stream below us. Whether or not a passage of time might indicate that it would be wise for us to enter into a joint venture of this sort I can't say at this moment. I think, if I had to make a prediction, that perhaps it may not happen while I am with the company because I am getting close to retirement age, but somewhere along the way this may come, because it is not only the type treatment that we are providing now but even much better treatment that will be required, and I think the regional approach certainly has many advantages and with the government having to fund so many public projects, I think it makes a lot of sense.

MR. WHITE: Well, of course, as the discussions earlier indicated, there appears to be no handle for really implementing one of these plans or at least that hasn't come to light in the discussions heretofore, and of course this is a prime concern of the conferees as to how to go about getting a reasonable system in. I think certainly this is by far the most desirable way to handle the problem that is in this particular valley.

MR. LOTT: I would make this one comment, that based on what the city of Aiken people said, they probably are much like the city of North Augusta, so far along with their plans and projects that it might not be wise to try to include them, but certainly insofar as the valley itself is concerned all the way down to the river it makes pretty good sense.

I can't speak for United Merchants. They will have to speak for themselves. They may also be so far along that this would be impractical, I don't know.

MR. WHITE: But from a standpoint of meeting standards, this might be the only way that it can be done.

MR. LOTT: It might well be.

MR. WHITE: That is a strong possibility.

MR. LOTT: Yes, it might well be.

MR. WHITE: Mr. Traina.

MR. TRAINA: First, Mr. Lott, that was a very fine statement.

MR. LOTT: Thank you, sir.

MR. TRAINA: There are a number of items in there, though, that maybe sometime after this meeting we can discuss in a very philosophical way. I would just like to say that when I am 125, if I ever get that way, and if I am not antiquated, why, that is just fine. (Laughter.)

There is one point on this chromium situation. That to me is a very real problem.

MR. LOTT: It is.

MR. TRAINA: I can appreciate your point of view, but we do have a situation here that we have found chromium in Horse Creek Valley, in the Horse Creek, and in fact in the Savannah River. Although it wasn't read this morning, there is in the appendix to the Federal report a rather extensive biological report that says, and I think I would like to read this into the record, that:

> Horse Creek for a distance of 1.6 miles from its mouth was a dead stream and contained no living macroinvertebrates. Sludge deposits in this creek contained 990 ppm of chromium, a concentration many fold higher than that reported to be toxic to aquatic life, including fish.

With a statement like that, you know, we do have a problem.

MR. LOTT: We recognize that problem, sir. All I hope is that we will be able to solve it together without--

MR. WHITE: Right.

MR. LOTT: --damage to the majority.

MR. WHITE: There is some information provided here by the State of South Carolina regarding a facility that just went in in another area that apparently they are achieving chromium reductions.

MR. LOTT: Do you know where this facility is?

MR. WHITE: I was trying to look here quickly. Mr. Heriot mentioned this. I believe it was the--

MR. HERIOT: That was your Gregg plant.

MR. TRAINA: It was the Gregg plant, was it not?

MR. LOTT: We are achieving some reduction, apparently, at our waste treatment plant, though I do not believe, to be perfectly honest with you at this point, that that plant was designed for that purpose and I don't believe at the moment that we can ever expect to achieve it through that plant without some extensive replanning or perhaps some knowledge that we currently do not have. This is the point I am trying to make.

MR. TRAINA: As I understand the role of chromium in your process, this is a valuable thing that a company like yours would not like to lose?

MR. LOTT: Well, let me say this. We have tried since the EPA report came out to use sodium hydroxide, I believe it is, and--is that correct, Henry?

MR. WOODHEAD: Peroxide.

MR. LOTT: Sodium peroxide. And then we have also tried oxitone. Both are oxidizing agents which we had hoped would do the same job as our sodium bichromate. They have not done the same job. We have to sell our goods in a competitive market, not only domestic but foreign, and if we don't turn out the type quality that our customers want, then that means that we don't sell the goods. And this is why it is so important to us at least to be given enough time to search for a reasonable solution to this problem.

I would like to make this comment, and I am not making it in any ugly way. The municipalities who appeared before you here today seemingly are going to be given considerably more time to achieve the solution to their problems. They have been knowing about them for a long, long time. We have just learned about the chromium problem and we would ask to be treated at least as reasonably as the municipalities.

MR. TRAINA: Of course you can appreciate the concern here, you know--

MR. LOTT: I can.

MR. TRAINA: --a discharge for this many years and the buildup of sludge--

MR. LOTT: I can.

MR. TRAINA: --apparently has wiped out all of the living organisms in at least Horse Creek and the continued discharge will start getting into Savannah River and it has already been demonstrated.

Would you like to comment on any ideas you might have with regard to recovery of chromium in your process so that you can reuse it before it goes into your treatment facility?

MR. LOTT: With the design of the plants we currently are operating under this would not be immediately possible. I think I mentioned in this report that we might have to redesign mechanically some of our processing which would require some time in order to segregate or separate those wastes from other wastes.

I have with me Mr. Jerry Johnson, who is the Assistant Vice President in charge of Operations, and Mr. Henry Woodhead, who is our Chief Engineer.

Jerry, would there be any comments other than that that you might care to make?

MR. WHITE: Please come up to the rostrum.

MR. LOTT: Jerry R. Johnson, Assistant Vice President, Operations.

## JERRY R. JOHNSON
## ASSISTANT VICE PRESIDENT, OPERATIONS
## GRANITEVILLE COMPANY
## GRANITEVILLE, SOUTH CAROLINA

MR. JOHNSON: I don't think that I can really add anything to what Mr. Lott has said. The present plant is not designed to remove chrome. The statement that was made a little earlier that chromium evidently had been removed in this plant I think was just evidence of two different people analyzing.

I really don't think we are doing anything there and I don't think we can.

The only possibility we have is what he has already stated to you and that is of separating those wastes that have chrome, designing some sort of precipitating method for getting the chrome out and handling it separately or finding a substitute, neither of which we have solved to date.

MR. TRAINA: Is your problem basically of collecting the various sources within the plant or is your problem a treatment facility for chrome? You have a number of sources within your plant?

MR. LOTT: It would be both.

MR. JOHNSON: It would be both.

MR. LOTT: Yes.

MR. JOHNSON: If we could remove the chrome, then of course we would not need a substitute.

MR. TRAINA: That is what I was getting at. You know, apparently there are problems with substitutes, and I realize that, in your process as well as others.

MR. LOTT: Right.

MR. TRAINA: So, therefore, let's deal with the question of chrome. Can you in fact get at your chrome sources within the plant and treat it separately?

MR. JOHNSON: Yes. This can be done, but it will require time and money because we have to separate them. Right now all wastes are channeled together, all industrial wastes in this plant go to one central point that was designed from the very beginning, and in these areas where sodium bichromate is used it has to be pulled out and put into a separate--gathered at a separate point, segregated, and this will require in-plant changes.

MR. TRAINA: Are you in fact going through your process determining where these sources are now?

MR. JOHNSON: We have already done this since the EPA report came out. We do know where they are. We know the quantities that we are using. We do not know how we can gather them together. Our first approach has been to find a substitute. The latest trial I think was maybe two weeks ago, as stated in this information that Mr. Lott had here.

MR. LOTT: The attachment to my statement will contain the data on that.

MR. TINSLEY: I have one question I would like to ask, Mr. Chairman.

MR. WHITE: Mr. Tinsley.

MR. TINSLEY: I recognize that you are making a concentrated or concerted effort to explore the use of your chromium as to whether you can substitute for or eliminate it from your waste stream. In a realistic sense what time span do you feel would be required to fully evaluate the chromium problem and come up with a solution to the chromium problem?

MR. LOTT: My guess would be minimum one year, probably maximum two years.

MR. TINSLEY: Let me ask one additional question. You mentioned that the facility was about 125 years old.

MR. LOTT: Well, that is the corporation, not the facilities.

MR. TINSLEY: The corporation, yes. But the facility itself is probably older than I am.

MR. LOTT: Oh, you are talking about the Gregg dyeing plant?

MR. TINSLEY: Yes.

MR. LOTT: It was built in 1950, the new plant.

MR. TINSLEY: O. K. The thing that I want to bring out is that on an existing facility of this nature it is sometimes difficult to segregate waste streams because of the way they were constructed. Is this a problem that you would anticipate handling?

MR. LOTT: There is no question about that as a problem. We very much hope we can find suitable substitutes. That is really the most logical and certainly the most practical thing, if it can be done. If that cannot be done, then it becomes a mechanical problem, engineering studies, pilot plant and final--because, after all, if you are going to spend that much money you want to be darned sure you are going to get results when you do.

MR. WHITE: Mr. Traina.

Did you finish, Mr. Tinsley?

MR. TINSLEY: Yes.

MR. TRAINA: Back on the substitute thing, and again I don't want to get into things that make money for companies and don't, but other plants of the kind that you operate, do they have substitutes or does everyone in this business use chromium?

MR. LOTT: I am certain that practically every plant similar to ours uses more sodium bichromate to oxidize its dyes than anything else. I think that is the case. I mean up to now it has been the best oxidizing agent.

MR. WHITE: Before you get away, I don't understand one thing on the question that Mr. Tinsley asked.

You said it would take one year to evaluate the possibilities of process changes that would collect your waste streams and put you in a position to handle it or did this include the time to evaluate possibilities of other materials?

MR. LOTT: I would hope, Mr. White, that if we actively work on it, as we have been doing the past several months, that within 1 year's time we could certainly abate to a considerable extent the situation that we currently have. And I would say that if we were not able to do it within 1 year, then I said I think we could do it in a maximum of 2 years.

MR. WHITE: Well, now, I understood the question--

MR. LOTT: And that is an off-the-cuff--our engineers and chemists and the people who run the plant might want to chop my head off when I get back for saying that.

MR. WHITE: I am still a little confused because now you are speaking in terms of abatement. But I would like to pinpoint the time that you think it would require to do the studies that you feel are necessary and develop a proposed remedial program that would give a solution.

MR. LOTT: Mr. White, I wish I could answer that for you. I can't, but I will get that answer for you and furnish it to you just as soon as I can.

MR. JOHNSON: Mr. White, could I also reply, please?

MR. WHITE: Yes, please do.

MR. JOHNSON: Mr. Lott mentioned earlier that we had some 6,000 shades, 6,000 different colors. Assuming, No. 1, that we find a substitute for sodium bichromate, the next thing we have got to do is match 6,000 formulas with that substitute. You don't do that immediately.

MR. LOTT: And in a way that your customers will take your product. That is right important.

MR. TRAINA: I think the question, though, sir, was, assuming that you are not going to go the substitute route, what are you going to do about tying chromium out of the plant? Let's assume that that is not a reality at the moment as far as a substitute, that is why I asked the question.earlier, what can we expect from the company in terms of some plan that would shoot a target date to collect and treat chromium coming from your facility?

MR. LOTT: I think I answered that a moment ago by saying, first, we are now actively studying substitutes; 2, and we must work on the assumption that perhaps those substitutes will not be available, we will begin immediately to working on plans for mechanical treatment of those wastes, segregating them and getting rid of them. We are just as anxious as you are to do that.

The point I was trying to make is that it will require a reasonable amount of time. You are trying to get me to say how long and I wish I could tell you, but I can't.

MR. TRAINA: Well, say about a year--

MR. HOWARD: It amazes me how you Federal boys never use the word segregate and yet these southern folk have used the word twice. (Laughter.)

Do you want to have any guidelines about chrome? I mean what are we talking about? Are we talking about absolute recovery, are we talking about a tolerance at what level?

MR. WHITE: Well, as I see, I mean--

MR. LOTT: There really are no standards. Nobody has published any standards on chromium so far as I know.

MR. WHITE: This is what the conferees have to address and I would like to have all these facts out on the table so we can come up with some recommendation because we will have to address the problem and conceivably it could be in the form of asking for a feasibility report by a date certain.

MR. LOTT: Mr. White--

MR. WHITE: And in connection with that, then some of the EPA people would also have to look into the aspects or the technical--the state of the art with respect to the removal or recovery of chrome, chromium.

MR. LOTT: Mr. White, I would say to you this, that we deliberated a long time before we decided to stand up here and subject ourselves to the type questions that I am now getting and we decided that there wasn't any point in trying to hide our heads in the sand. We have always met things head on and that is the way we are going to meet this one. We are going to cure this problem somehow. But we will require a reasonable amount of time. How much time that will be, I cannot answer you at this moment, because the problem is really a brand-new problem. Had we been working on it for an extended period of time I think I could answer your question, but I can't at this point.

MR. HOLLIS: Mr. Chairman.

MR. WHITE: Yes, Mr. Hollis.

MR. HOLLIS: In this same vein, I would like to get it into the record as to the severity of the problem and the assurance or competence that it is as severe as has been indicated. I ask this primarily from the standpoint that admittedly the South Carolina Pollution Control Authority has not done the studies, QED, it does not have the data. I believe that the Federal conferee should indicate as to whether or not there has been adequate determination in this case to be sure that the problem is as stated or is there a possibility that this may be of the same nature as I believe a little earlier the question on phenol was concerned. It is solely for the purpose of determining whether or not in arriving at the solution to the problem that we really know what the problem is.

MR. TRAINA: In that regard, again I refer to a rather extensive appendix in the Federal report of the biology portion of our studies, and in that chromium was found in sludge deposits; I read the statement that was concluded by our biologists. Further on there was a--I must admit I really--let me read this statement here.

> These sludge deposits contained measured chromium concentrations of 670 ppm which appeared to be having a teratogenic effect on the midge larva.

The point is that I think that biologists agree that chromium has a toxic effect. I am sure that--

MR. JOHNSON: Could I ask a question about that, sir?

MR. TRAINA: Yes, sir.

MR. JOHNSON: One thing that would help us in our decisions, nowhere in this report does it tell whether the chrome is hexavalent or trivalent. As we understand it, the trivalent is less toxic than the hexavalent, and maybe some of those people here that prepared it can tell us. We don't know what you found.

MR. WHITE: Could we call Mr. Little back up?

MR. LITTLE: I think to answer that briefly, the analysis was on the basis of total chrome and the latest information that I have is that no particular form is perhaps more toxic than another, that trivalent and hexavalent forms are toxic. This is based on something I believe fairly recent.

MR. HOWARD: Hasn't it been common knowledge that chrome is a toxic metal and they used to have at one time a tolerance of 1 mg/l? For total chromium.

MR. LITTLE: Chrome is a toxic metal. At one time it was thought that perhaps hexavalent was the most toxic form, but I think now current information says that all forms are equally toxic and in terms of levels being discussed in an effluent, I believe we are talking about levels at this point, say, in some of the industrial permits, and this is information which is subject to some review, of approximately 5 hundredths, .05, ppm.

MR. HOWARD: Let's don't get into the trash act again, though.

MR. WHITE: Let me do that to this minor degree, Mr. Howard. I just want to point out the fact that on the material that we have which indicates concentrations or loadings from many of these discharges that we show that there is 701 pounds per day of chromium coming out of, I assume, the waste treatment plant that you have there, so this to a degree verifies the

Federal report with respect to the fact that, of course, this is a problem.

MR. LOTT: Our own studies have verified the, well, the amounts originally there and the amounts, I think, currently there, which have been reduced, and we recognize it as a problem, sir. But I again say that to us it really is a brand-new problem and had we had knowledge of the problem being as severe as it is, we would have done a lot more work on it than we have done.

MR. WHITE: I appreciate your position.

MR. LOTT: And I assure you, sir, that we are going to find the solution to it. We will do that.

MR. WHITE: Well, as I say, I appreciate your position and your statement and I recognize the problem and I hope that we can find a mutually satisfactory solution.

MR. LOTT: Thank you.

MR. WHITE: Any other comments or questions?

MR. TINSLEY: None.

MR. WHITE: Mr. Traina?

MR. TRAINA: No.

MR. WHITE: Mr. Howard?

MR. HOWARD: I think that Graniteville has made a lot of progress in the last 3 or 4 years, actually. I am glad to hear about it.

MR. LOTT: We think we are ahead of the pack, so to speak.

MR. TINSLEY: Mr. Chairman, I would like to next call on Mr. Raymond A. Jankowski, of Kimberly-Clark Corporation.

## RAYMOND A. JANKOWSKI
MILL MANAGER
KIMBERLY-CLARK CORPORATION
BEECH ISLAND, SOUTH CAROLINA

MR. JANKOWSKI: Mr. Chairman, conferees, ladies and gentlemen.

My name is Raymond Jankowski and I am the Mill Manager of the Kimberly-Clark Corporation's Beech Island, South Carolina, plant.

We appreciate this opportunity to make a statement, as we are proud of what Kimberly-Clark is doing in the area of pollution abatement nationally and particularly here at Beech Island. Our corporate posture for a number of years has been to spend the money and do what is necessary to protect and improve our environment. Kimberly-Clark has been doing this long before environmental concern held the national interest it now does.

Prior to the construction of the Beech Island Mill, back in 1966, we approached the Georgia Water Quality Control Board and the South Carolina Pollution Control Authority to determine what water effluent standards we would need to satisfy. After committing ourselves to reaching the standards of the State of South Carolina, we proceeded to design and install an effluent treatment system that must rank as a model in the industry. The original standards have been tightened with the passage of time, but our system continues to discharge effluent that meets or betters the high quality called for by the order and standards issued our mill. We respectfully direct your attention to the Environmental Protection Agency report of August 1971, as revised February 1972, "A Report on Pollution in the Middle Reach of the Savannah River," as a measure of how well our water treatment system is working. Quoting directly from the Conclusions on page 7 of the report:

> Kimberly-Clark Company was providing adequate treatment for its wastes, and the effluent did not have a measurable effect on water quality in the Savannah River.

We will, of course, continue to comply with water quality effluent standards in the future just as we have in the past. Also, as in the past, we will make use of every opportunity that arises to further improve on our abatement performance. We appreciate the cooperation and dedication demonstrated by the State authorities of South Carolina, and heartily agree with them that conformance to law should mean conformance to the intent as well as to the letter.

End of my statement. Thank you.

MR. WHITE: Thank you, Mr. Jankowski.

Comments or questions?

MR. TINSLEY: None.

MR. HOWARD: Keep up the good work.

MR. JANKOWSKI: Thank you.

MR. TINSLEY: Mr. Chairman, the next person that I have on my list, someone has scratched through it, but I will read the name and ask,if he is still with us,would he like to make a statement.

Dr. C. G. Childress, South Carolina Conservation Chairman representing the Sierra Club, is he here?

I would next call Mr. W. F. Thompson, United Merchants and Manufacturing Company.

Mr. Thompson.

MR. WHITE: Let's go off the record just a second.

(Off the record.)

MR. WHITE: Let's go back on the record.

WILLIAM F. THOMPSON

ASSISTANT MANAGER

CLEARWATER FINISHING PLANT

UNITED MERCHANTS' PLANTS

CLEARWATER, SOUTH CAROLINA

MR. WHITE: Please proceed, Mr. Thompson.

MR. THOMPSON: Mr. Chairman, conferees, ladies and gentlemen.

I am William F. Thompson, Assistant Manager of Clearwater Finishing Plant, and I am here today representing United Merchants and Manufacturers facilities along Horse Creek in Aiken County, South Carolina.

My next few statements, my next few sentences, are not from our prepared statement. I am also representing the Valley Public Service Authority and after giving this prepared statement I would like to make some comments regarding the Valley Public Service Authority and its position.

Back to my prepared.

On behalf of United Merchants, I appreciate the opportunity to come here today to present United Merchants' position regarding industrial waste treatment along Horse Creek Valley. United Merchants' has always been vitally interested in pollution abatement and has always cooperated in every way with all agencies concerned with pollution abatement. The company will continue to do everything possible in order to comply with the laws of State and Federal governments and carry out its responsibility towards the elimination of pollution.

In April 1970 United Merchants received a cease and desist order to eliminate pollution of Horse Creek and Little Horse Creek by April 15, 1973. Plans for a program of waste treatment were submitted to the South Carolina Water Pollution Control Authority and approved in June 1971. Construction is now under way for a 7 MGD plant at Clearwater Finishing Plant, Clearwater, South Carolina. This plant will consist of equipment for screening, extended aeration, clarification with provisions for recycling activated sludge, aerobic digestion of sludge, sludge dewatering and disposal. This plant is designed for 85 percent reduction in BOD, producing an effluent which will meet the requirements of the South Carolina Water Pollution Control Authority.

This concludes my prepared statement. If there are any questions, I will be happy to try to answer them.

MR. WHITE: Mr. Traina.

MR. TRAINA: At the risk of sounding like an old record, sir, the chromium problem, apparently some of these facilities have the kind of problem that we just discussed earlier. Any thoughts, ideas, suggestions?

MR. THOMPSON: Well, I believe in the EPA report, one of the reports I remember reading, that Valchem showed a chromium content of some 65 or 70 pounds in its effluent. We have recently made analysis, in fact within the last month, and we find that the chromium content of the effluent from Valchem is less than 1 ppm. And in evaluating and analyzing the reason for the difference, I think I have a very good and logical explanation.

The original data concerning chromium content of the effluent from Valchem was made on an effluent which at the time included cooling water. At this time the cooling water which was drawn directly from Langley pond to circulate through the cooling system of reactors was mixed with the industrial discharge and, of course, discharged into Horse Creek. And, of course, the effluent from Valchem at that time would have whatever chrome was in the water that was drawn from Langley pond.

Since that time we have separated the cooling water from the industrial waste because the cooling water volume was much greater than the industrial waste. That was part of the program of pollution abatement.

And our recent analysis shows less than 1 ppm of chrome in the effluent from Valchem.

MR. TRAINA: What about your Clearwater Finishing Plant? There was some chrome there.

MR. THOMPSON: Clearwater Finishing Plant, I believe it is 7-1/2 lbs/day of chromium. This comes primarily from sodium bichromate that is used for oxidizing vat and sulfur colors. Of course we would be faced with the same problem as Graniteville, but not as great because we do not dye as much vats and sulfurs as they do.

MR. TRAINA: Is that the basic difference as to why the amount of chromium is less here?

MR. THOMPSON: Yes, sir. We are primarily a print works and do very little plain shade dyeing.

MR. TRAINA: That is all the questions I have, Mr. Chairman.

MR. TINSLEY: I would like to point one thing out so that we will be aware of it in our considerations.

On the 3rd of March of this year the Authority collected water quality samples above, at, and below the outfalls from the facilities we have been discussing and the results of those analyses are in the appendix of the Authority's report. For example, on the Valchem outfalls,Nos. 1 and 2, the total chromium concentration was 0.38 on No. 1 outfall and 0.92 on No. 2.

On the Clearwater Finishing the effluent was non-detectable.

So there is quite a bit of question in my mind as to the analyses that have been run by all parties concerned. This is an area where I think we need to do some more looking before we make any serious decisions.

MR. TRAINA: What are the figures for the Gregg and the other facility we heard about?

MR. TINSLEY: The figure we had--these are total chromium figures--11.09 for the Gregg sewage treatment plant outfall and downstream from that facility it was 1.04.

Mr. Thompson indicated that he was also involved in the Valley Public Service Authority. The conversations we have had earlier this evening, a lot of the questions that were raised, Mr. Thompson is probably in a better position to respond to those than any of the other individuals, if you care to raise any of those questions at this time.

MR. WHITE: All right.

MR. HOLLIS: I wondered, Mr. Thompson, if you could give us a general status of the Valley Public Service Authority? I believe this would be most applicable.

MR. WHITE: And start by--have we heard what the Valley Public Service Authority is, I mean what type entity?

MR. THOMPSON: Let me give you some background information which I think will be helpful.

The communities along Horse Creek, as you have heard mentioned before, are unincorporated except I believe one, which is Burnettown. And essentially the communities from just below Warrenville downstream to include Clearwater are unincorporated. There is a water and sewer commission in Clearwater, Bath and Langley that operates the water system and the sewer collecting system.

In view of the fact that there was no legal body who had authority to make evaluations, make studies, and to implement a plan, a law was passed in July of 1969 forming the Valley Public Service Authority. This consists of nine members selected from Aiken County and they are appointed by the Governor upon recommendation by the Aiken County legislative delegation. It so happened that I was asked to serve on this commission and when it was formed I was elected as Chairman.

On the day that we were organized we were handed a preliminary report on water and sewerage facilities for Horse Creek. This was prepared for the Aiken County legislative delegation by Jones and Fellows Engineering concern of Augusta, Georgia. This preliminary recommendation gave several alternatives to the solution of waste abatement in Horse Creek.

One of these envisioned the construction of a centralized waste treatment plant on the Savannah River at the confluence of Horse Creek large enough to accommodate the wastes from Graniteville--I mean from Aiken, the industrial wastes from Graniteville Company, United Merchants, the domestic wastes along Horse Creek, and the wastes from North Augusta. It would also have sufficient capacity so that other areas in between these communities could be developed and sewered which would also include Belvedere, South Carolina. There were other alternatives of a smaller scope.

We were given this report for study and evaluation. We studied and evaluated this report and it was the Authority's opinion that the construction of a centralized waste treatment plant on the Savannah River near the confluence of Horse Creek was the best overall plan for solving the pollution abatement problem. We reported this to the Aiken County legislative delegation. They concurred with us so we attempted to implement this plan, first by contacting the people and the agencies involved.

We first contacted the city of Aiken. We were received very cordially by the city manager and the city engineer. We outlined the program to them and they looked favorably upon it but would like to study it.

We received a letter in about two weeks saying that they were of the opinion that they were so far along with a planned addition to that plant that they thought it best for the city of Aiken to proceed on their own. We contacted the Graniteville Company. There again we were very favorably and cordially received. We were told that it is a shame that this Authority had not been formed 3 or 4 years ago, that they would be very interested in joining in with a centralized system, but due to the fact that their plant was just about ready to go on stream--as well as I remember this was in October or November of 1969, and their plant was planned to go on stream in February of 1970--that they thought that it would be impossible for them to join in with this overall plan.

We contacted the officials of United Merchants and they were willing.

We contacted the three water and sewer commissions in the valley, that is Clearwater, Bath and Langley. We did not get either a negative or an affirmative response from them. I think the reason for it is because their water rates are very, very low. In fact, their water rates are about half of the water rates of the other people around them. Anything that would be done for them is going to cost more money.

We contacted North Augusta. We got a favorable response. We met with the mayor and the Committee of Public Works and they wanted to study the proposal, which they did, but in a few weeks received a letter saying that North Augusta had put too much work and effort into their plans for a waste treatment plant and they thought it best to proceed on their own.

So this changed our thinking altogether. So the next plan that we thought would be the best alternative was the construction of a waste treatment plant in the vicinity of Clearwater but sponsored or implemented by the Valley Public Service Authority.

The Valley Public Service Authority has no taxing powers. It cannot use any tax money for construction of water or sewer facilities. It can get financing from governmental grant, grant from private individuals or industry, and the sale of revenue bonds.

We consulted with HUD, in fact a representative of HUD came to Clearwater, and we went over the area and we explained the alternative plan which we thought would be possible and his opinion was that it was a good plan but we did not have a very good chance of financing it, based on the fact that the Valley Public Service Authority was new, inexperienced, did not have a history of managing finances or implementing any kind of project like this.

At this time pressure was being placed upon United Merchants to go ahead with a plan, so we went to United Merchants and asked them would they be willing to cooperate with us in this respect: If they were to build a plant for the treatment of the United Merchants wastes, could they build it large enough to handle the domestic wastes from the communities along Horse Creek? This was the final arrangement or agreement, so that the Valley Public Service Authority wrote a letter to United Merchants officials recommending that they proceed on their own to build a waste treatment plant but of sufficient capacity to handle the domestic wastes from the communities along Horse Creek. So that is where we are today.

Now, the problem with the Valley Public Service Authority is financing. United Merchants is constructing a plant with sufficient capacity. The problem now is to build an interceptor line and the necessary pumping stations to collect the wastes from the four outfalls from Clearwater, Bath, and Langley and get it to the United Merchants plant.

With no income from water, our engineers advise us that it is very unlikely that we would be able to sell sufficient revenue bonds to finance the remaining two-thirds of the money that we would have to raise.

MR. WHITE: Roughly, do you have an estimate of what this sum would be?

MR. THOMPSON: The sum for the interceptor sewer line I believe is in the neighborhood of $450,000.

Mr. Zimmerman, is that correct?

MR.ZIMMERMAN: Yes.

MR. TRAINA: You retained a consulting engineer, the Authority had retained a consulting engineer?

MR. THOMPSON: Yes.

MR. TRAINA: And actually had engineering plans?

MR. THOMPSON: Yes, sir. After the evaluation of the original preliminary report, we retained a consulting engineer, Mr. Harry Zimmerman.

MR. TRAINA: The problem was apparently coming up with the local share as far as the Federal program is concerned?

MR. THOMPSON: Yes, sir. Yes, sir.

MR. TRAINA: The Authority has authority to issue revenue bonds, did you say?

MR. THOMPSON: Yes, sir.

MR. TRAINA: But not to tax?

MR. THOMPSON: Not to tax.

MR. HOWARD: What is the source of the public drinking water supply there, groundwater or surface?

MR. THOMPSON: The town of Clearwater obtains its water--buys water from the Clearwater Finishing Plant.

MR. HOWARD: Where does that come from?

MR. THOMPSON: That comes from the Clearwater Lake and then is treated in a regular filtering system and chlorinated, of course. Now, the water system at Bath and Langley is surface--is deep wells.

The town of Clearwater, Bath and Langley is sewered, at least the major portion of it, but the waste is being discharged into Little Horse Creek at Clearwater and Horse Creek at Bath and Langley untreated.

MR. HOLLIS: Mr. Thompson, could you give the general area that the Valley Public Service Authority encompasses, the general boundaries of it?

MR. THOMPSON: Yes, sir. If you will begin at Interstate 20 where it crosses Savannah River going northeast along Interstate 20 to a line or to a point, say, directly west of Aiken and then towards Aiken just east and south of Aiken to Pine Log Road, and then along Pine Log Road to a point in Beech Island and then from that point on to the Savannah River and then up the Savannah River back to I-20. But it excludes all areas who already are providing water and sewer service.

Another stumbling block of the Valley Public Service Authority is that the Valley Public Service Authority cannot go into any area that already is providing water and sewer service, but there is nothing to keep any other agency or private water company from extending out from its present area to provide water and sewer service.

MR. TRAINA: The area you just described, sir, would include these areas that were referred to in the State's report, Beech Island rural community water district, Breezy Hill water district?

MR. THOMPSON: It includes Breezy Hill, but maybe only a small portion of Beech Island, what is known as Beech Island. The major portion of what is knownas Beech Island would be outside of this area.

MR. TRAINA: One other question, sir. How does the district relate to this lower Savannah group we heard about or this metropolitan COG group that was mentioned?

MR. THOMPSON: Well, it has no connection other than the fact that we keep them informed of our plans and we recognize and like to have any guidance that we can get from them. But other than that it has no connection.

MR. WHITE: I am still a little hazy on the financing or your potential financing with revenue bonds.

But first, before getting into that, does the Authority have any money at all now, I mean that could be directed toward the construction of these interceptor lines?

MR. THOMPSON: The only money we have right now is-- in the beginning we had absolutely no money. We operated for 18 months without a penny. And we saw that we would need an additional engineering guidance, so we went to the Aiken County legislative delegation and received a $12,500 loan, five years, interest free. Now, we still have about $6,000 of that money.

MR. WHITE: All right. Now, likely you have stated it and I just didn't follow it. How could you set rates and on what would you set rates, on what water supplies and whatnot, to give you revenue to support a revenue bond issue?

MR. THOMPSON: The estimated rates that the engineer has come up with based on the cost of putting in an interceptor sewer and pumping the waste to the United Merchants plant is a monthly charge of about $4.85, I believe, for sewer. These people are not paying any sewerage fee now and their water fee is like $2.50 a month.

MR. WHITE: But they are presently in a water and sewer district separate from your Authority?

MR. THOMPSON: It is three water and sewer districts separate from the Authority.

MR. WHITE: Who has authority to require those sewer districts to impose these rates if this proves to be a reasonable way to go?

MR. THOMPSON: I am not sure. We have talked with legal authority, who advises us that we would probably have to have a referendum of the people. That is the best information I have been able to get.

MR. WHITE: How would you speculate with respect to a referendum assuming you could hold one? Do you think there would be any interest in this thing?

MR. THOMPSON: I think that if the people who are getting water from--now, this is only my personal opinion--the people who are getting water from their own private wells and are using septic tanks would probably vote in the affirmative, but these people who have water from the public system and they have sewerage or sewer system would probably vote no.

MR. WHITE: You say that this would require a $4.50 sewer charge?

MR. THOMPSON: Sewer charge.

MR. WHITE: What water charge are these people that are on the supply system now--

MR. THOMPSON: Well, I would say it averages $3 a month, some of it is less.

MR. TRAINA: I wish that was my water bill. (Laughter.)

MR. WHITE: Any other comments or questions?

MR. HOLLIS: Mr. Thompson, maybe I shouldn't even ask you this, or maybe I will make it in a statement, that as the Public Service Authority exists right now, as structured and under the present law, it is marginal that it could in fact plan for, develop and operate a regional system?

You may or may not want to comment on that, but I want to bring into the record that there are limitations, although it exists as a legal entity, that there are many unanswerable and unworkable situations as it stands right at this time.

MR. THOMPSON: As it stands today, yes, sir. I will say this, it is just a pity that the Valley Public Service Authority or some similar organization was not formed at least 10 years ago. The Valley Public Service Authority could do the job, but under the existing circumstances of financing, that is the key to the solution or key to the implementation of a plan. If it could get the money, it could do it.

MR. TRAINA: Just one maybe last question.

On that first proposal you discussed, the regional plan at the mouth of Horse Creek, and so on, serving the entire area, was there a cost associated with that? Did your engineers come up with one?

MR. THOMPSON: We came up with an estimate, yes, sir, in the preliminary.

MR. TRAINA: Would you like to--

MR. THOMPSON: Well, as well as I remember it was in the neighborhood of $12 million.

MR. TRAINA: That included sewer collection and treatment?

MR. THOMPSON: Yes, sir.

MR. TRAINA: For the entire Horse Creek Valley?

MR. THOMPSON: Yes, sir.

MR. WHITE: Do you have a published report on that?

MR. THOMPSON: Yes, sir.

MR. WHITE: Would it be possible for you to make one available?

MR. THOMPSON: Yes, sir.

MR. WHITE: I don't plan to put it in the record or anything, but I think it could be helpful.

MR. THOMPSON: I will be glad to provide you with one.

MR. WHITE: And one last point just so that I am clear.

If you were going with the United Merchants treatment plant to treat the wastes from these small communities there, the only thing it would take would be for those districts--and I said "this only"; it is a big thing--would be a $4.50 charge, and you think based on that that you could get revenue bonds that would finance these interceptors and whatnot?

MR. THOMPSON: Well, the advice that I have is that just income from sewerage that we would have a most difficult time of selling revenue bonds for two-thirds of the cost.

MR. WHITE: For two-thirds?

MR. THOMPSON: Yes; under the present law we are entitled to a one-third grant.

MR. WHITE: I see.

MR. HOLLIS: I would like to make a statement here again for the record that while the present funding is at the 30 percent plus the 3 percent bonus for planning, the South Carolina General Assembly has in both Houses passed a State matching program which would make possible a State matching up to 25 percent and under the present law the Federal grant would move from the 33 to 55 percent. I think it also ought to, in consideration of this, the Federal legislation, the Senate bill would have a 60-40 ratio under eligible parts of PL-660 moving up to 70 percent if the State put in 10 percent. The House bill has a similar 60-40 ratio without State participation and goes to a 75-15-10 ratio if the State were to participate up to

15 percent.

So I think that on the negative side of what we have said here is that the legal authority or the working arrangements are difficult at this time but the opportunities are greater and that perhaps the--and we do know that the delegation, the Aiken County delegation, has been seized with this problem and hopefully will get to a solution of the problem.

One of the areas, though, that I think here again ought to be clear is this question of interim planning and this question of documenting to the Environmental Protection Agency that the money is well spent. The requirement is such that there is a need for monies for planning which have not been made available and as of this time, insofar as the Environmental Protection Agency is concerned, we do not have anything definite that would indicate that we would have this money in advance for this plan. We must, therefore, rely upon monies for planning that have been made available by HUD 701 funds and Farmers Home Administration and hopefully the plans that have been made through these monies would be acceptable in the documentation to the Environmental Protection Agency of two most important things: One, that water quality is attained and maintained; and two, that the project is the most cost effective way of doing it.

MR. WHITE: Any other comments or questions?

If not, thank you very much, Mr. Thompson. Your testimony was very helpful.

MR. THOMPSON: Thank you.

MR. TINSLEY: Mr. Chairman, that concludes those that have indicated a desire ahead of time to make a statement. There may be some in the audience that would like to make statements.

MR. WHITE: Let's issue the call now.

Is there anyone here who hasn't made a presentation and would like to?

Fine. I guess this concludes this open part of the conference. We plan to recess in a few minutes. The conferees will go into executive session late this evening and continue tomorrow and will plan to be back at 3 p.m. tomorrow afternoon with preliminary conclusions and recommendations as I outlined at the outset of the conference. This might seem like a long time, but we have a lot of work to do and I want to allow sufficient time to develop these. Hopefully we won't have problems meeting that particular deadline. I know this might work a hardship on some members of the press, but that is just the way we are going to have to do it.

With that we stand recessed until tomorrow at 3.

(Whereupon, at 4:45 o'clock an adjournment was taken until 3 o'clock, Thursday, March 23, 1972.)

## AFTERNOON SESSION

THURSDAY, MARCH 23, 1972

3 o'clock

MR. WHITE: Let's go back in session.

Well, the conferees have been in executive session and I am happy to say that we have developed revised conclusions and recommendations. I will proceed to read this statement and these conclusions and recommendations now. At the end of that time I will call on the conferees for any statement that they might have relative to anything in the conclusions and recommendations or anything that has transpired with respect to the conference.

Based on the data and testimony presented at the conference, the conferees unanimously agreed upon the following conclusions and recommendations:

The conclusions are that:

1. Discharges of untreated and inadequately treated municipal and industrial wastes (lack of secondary treatment) originating in Georgia and South Carolina cause violation of the water quality standards of the interstate waters of the Savannah River (middle reach), endangering the health and welfare of persons in both States. This violation is subject to abatement under the provisions of Section 10 of the Federal Water Pollution Control Act, as amended.

## Conclusions and Recommendations

2. Untreated and inadequately treated waste discharges and combined sewer overflows from the sewer systems serving Augusta, Georgia, and North Augusta,South Carolina, violate fecal coliform bacteria criteria in the interstate waters of the Savannah River.

3. The city of North Augusta will not meet the previously established order of the South Carolina Pollution Control Authority.

4. There are areas within the city of Augusta and Richmond County, Georgia, with malfunctioning septic tanks, privies and illicit discharges.

5. Chromium deposits violating water quality standards in the Savannah River result from the waste discharges in Georgia and South Carolina. Known sources in South Carolina are the Gregg Mill, Valchem Chemical Company, and Clearwater Finishing Plant.

6. Butler Creek, at the confluence with the Savannah River, is grossly polluted by the discharge of inadequately treated municipal waste from the Augusta sewage treatment plant and from grossly polluted urban drainage from the Augusta, Georgia, area.

7. Oates Creek, Camille Ditch, Rocky Creek, Phinizy Ditch and Beaverdam Ditch receive untreated and inadequately

treated municipal and industrial wastes from the Augusta, Georgia, area and are little more than open sewers.

8. Columbia Nitrogen Corporation in Georgia discharges inadequately treated wastes to Beaverdam Ditch.

9. Nipro, Inc., in Georgia discharges inadequately treated wastes to the Savannah River.

10. Spirit Creek is grossly polluted by the discharge from the Continental Can Company in Georgia. Data reported at the conference dictates the need for further investigation of the characteristics of this waste discharge.

11. Horse Creek and its tributary, Little Horse Creek, in South Carolina are grossly polluted from the discharge of inadequately treated textile mill wastes and raw and inadequately treated sanitary wastes.

12. High turbidity has been observed in Horse Creek at the South Carolina Highway 125 Bridge.

13. Water quality in Horse Creek violates water quality standards adopted by South Carolina.

14. Lack of regional water quality management planning in the Horse Creek Valley is delaying progress toward abatement of water pollution.

15. Kimberly-Clark Company in South Carolina is providing adequate treatment for its wastes, and the effluent

does not have a measurable effect on water quality of the receiving waters or in the Savannah River.

16. Progress is being made by Aiken, South Carolina, toward the construction of improved and expanded waste treatment facilities.

17. Organic wastes and thermal discharges receiving inadequate treatment from facilities serving the AEC Savannah River plant cause localized water degradation in plant tributaries and affect the water quality in the Savannah River.

18. Facilities discharging to Savannah River tributaries within the AEC Savannah River plant property are subject to the provisions of the South Carolina water quality standards based on Executive Order 11507.

19. The quality of releases from the Corps of Engineers operated Clark Hill Dam may be in violation of water quality standards in the Savannah River, especially as it concerns dissolved oxygen and dissolved mineral concentrations.

The recommendations are that:

1. The city of Augusta upgrade the Butler Creek sewage treatment plant to secondary treatment with a minimum of 85 percent reduction of 5-day BOD by July 31, 1973. All wastes now being discharged without treatment during dry weather flows, either directly to the Savannah River or to existing city

collection system, be transported to the Butler Creek sewage treatment plant by July 31, 1973. The city of Augusta will award contracts by July 1, 1972, subject to Federal and State approvals.

2. The city of Augusta, Georgia, and the county of Richmond, Georgia, enforce their sewer use ordinances and make any needed modifications required to properly protect the sanitary sewerage system and provide a report on this matter to the conferees through the State by July 1, 1972.

3. There are areas within the city of Augusta and Richmond County with malfunctioning septic tanks, privies, and illicit discharges. In order to correct these problems and provide the community with an adequate sewerage system, the city of Augusta is to submit a plan to the conferees through the State of Georgia by January 1973 for the installation of a sewerage system to alleviate these conditions. The plan is to be submitted with a schedule for implementation for review and approval by the State.

4. Richmond County in cooperation with the city of Augusta is to submit a plan to the conferees for the State of Georgia by January 1973 to provide adequate sewerage for unpopulated areas of the county outside of the corporate limits of Augusta. The plan is to be submitted with a schedule for

implementation for review and approval by the State.

5. The city of Augusta is to prepare a report on the feasibility of a program of separating existing combined storm and sanitary sewers for submission to the conferees through the State by January 1, 1974.

6. As directed by the State of Georgia, Columbia Nitrogen Corporation is to submit a final engineering report by August 15, 1972, for the wastewater discharge from the nitrogen plant. Any modifications or treatment required by the conferees after review of the report will be installed by the end of 1972.

7. Nipro, Incorporated, will provide secondary treatment for 0.4 MGD of wastewater from the caprolactam plant with a discharge not to exceed 4,500 lbs. of $BOD_5$/day, which reflects 97.6 percent total reduction of this plant's raw waste load. This treatment will be provided concurrent with expansion of plant production, tentatively scheduled for June 1, 1972.

8. The Continental Can Company is to maintain and operate the existing secondary treatment system to attain optimum levels of treatment. The company will modify the existing treatment facility to provide for a minimum of 85 percent reduction of $BOD_5$ and divert the effluent directly to

the Savannah River downstream to Spirit Creek by July 31, 1973.

9. Continental Can Company, EPA, and the Georgia Water Quality Control Board will conduct a joint study to determine the extent of mercury and zinc contamination of the plant's effluent and report its findings and program for remedial measures as necessary to the conferees by June 1, 1972.

10. By January 1, 1974, Continental Can Company is to evaluate and report to the conferees through the State the impact of the color in its effluent on the water quality of the Savannah River.

11. The city of North Augusta, South Carolina, install and operate satisfactory secondary waste treatment facilities as required by the State of South Carolina. The conferees recognize because of possible court action the inability to establish a firm completion date, but urge the Authority to seek a remedy which will result in the completion of a treatment facility at the earliest possible date. A status report shall be submitted to the conferees by June 1, 1972.

12. The Gregg Mill of Graniteville Textile Company, the Valchem Chemical Company and the Clearwater Finishing Plant, submit through the South Carolina Pollution Control Authority to the conferees by October 1, 1972, a feasibility

report on the removal of chromium from their wastes and the impact of chromium on the water quality of the Savannah River. The report should fully evaluate all possible alternatives for reducing the chromium and include an implementation schedule for abatement. The companies should proceed immediately with any interim steps which would reduce the chromium discharge.

13. The Valley Public Service Authority, or any other agency or agencies as agreed between the South Carolina Pollution Control Authority, the Environmental Protection Agency and local authorities, initiate action to establish a reasonable wastewater collection and treatment system to serve industries and communities in the Horse Creek Valley, including the city of Aiken, South Carolina. A report, based on a comprehensive study which addresses the most cost effective way in which water quality can be met, will be submitted to the conferees by November 1, 1972. The study will be based on the provision that communities and industries under South Carolina Pollution Control Authority orders shall continue to implement plans for their own treatment facility unless it can be proven that the regional system can correct their pollution problems at an earlier date. Implementation shall consist of the following schedule of events.

A. Determine the responsible agency to assume leadership role by June 1, 1972.

B. Decision on the procurement of funds with which to conduct the study based on seeking a 50 percent Federal and 50 percent State or local basis by June 1, 1972.

C. To assist in a cooperative effort with all parties involved in making a decision concerning feasibility of the regional system, South Carolina Pollution Control Authority and the Environmental Protection Agency will make a detailed assessment of the existing legal authority and determine what additional legislation, if any, is necessary to implement a regional plan in the Horse Creek Valley. A report of these findings will be submitted to the conferees by June 1, 1972.

D. Should establishment of a responsible agency or funding not be arranged as described above, the conferees shall reconvene to determine a proper course of action by July 1, 1972.

14. The AEC Savannah River Plant comply with Executive Order 11507 and the South Carolina water quality standards for streams on the plant site. In addition, the AEC facility should submit to the conferees a status report of the present practices with regard to thermal discharges, including an evaluation of the effects those discharges have on the receiving

water within the property boundaries of the AEC facility by October 1, 1972. Secondary treatment of sanitary wastes is to be provided by June 30, 1973.

15. The South Carolina Pollution Control Authority in cooperation with the Environmental Protection Agency investigate the cause of high turbidity in Horse Creek at South Carolina Highway 125 and report to the conferees by July 1, 1972, on the cause and necessary remedial action to abate this pollution.

16. The Corps of Engineers investigate possible violations of water quality standards caused by releases from Clark Hill Dam and report back to the conferees by October 1, 1972, of their findings and any necessary remedial actions which must be instituted to correct any deficiencies.

That concludes a reading of the conclusions and recommendations which the conferees developed. I would like to add something that is probably a little obvious to you.

This is a preliminary set of conclusions and recommendations and likely there will be at least refinements in the language. We work right up until time to come on and make the reading and some things still must be corrected.

I would also like to point out that these are unofficial at this point. They will not become official until they are approved by Mr. Ruckelshaus, and they will be immediately forwarded to him for consideration.

With that, I would like to now call on the conferees to see if they have any concluding statement.

Dr. Webb.

DR. WEBB: First of all, I want to apologize for not being here for all of this conference. I was in Washington last week and picked up one of these flu bugs and I haven't completely gotten over it yet, but I am back pretty well on my feet.

With that background, the statements which I make might be repetitious because I don't know all that happened yesterday. But there is one thing which I want to emphasize and that is that we have not been sitting still in correcting these conditions. Neither the Pollution Control Authority, EPA, nor the local industries and municipalities have been sitting still.

Two years ago the Pollution Control Authority issued orders to at least two installations in this area to provide treatment. United Merchants was one of them. They have proceeded, their plant is under construction at the present time, and is scheduled for completion within approximately 1 year from today.

## Conclusions and Recommendations

North Augusta has not made as much progress as we would like, but they have not been sitting still.

Aiken is in the process of making plans and they have, as I understand it, presented a statement at this hearing to the effect that they will be willing to cooperate with an overall program for the entire area.

The Graniteville mills, Gregg mill I believe is the right name, has without an order proceeded to build waste treatment facilities. That plant is in operation. It is not completely doing the job it was designed for, but I am certain that it will be as soon as they can iron out the bugs in it.

J. P. Stevens down in Allendale County was also issued an order and they have complied. Their facility is in operation. Again it has just gone into operation and we are not in a position to say that it is doing the job yet because we simply haven't had the time as of this date to evaluate it. We have no reason to believe that it will not do the job.

You will note that most of these entities which I mentioned are industries or municipalities which have been in those locations for a long period of time and consequently they have had lots of catching up to do. On the other hand, we have one or two new industries, new installations, in the area and in all cases they have done everything which we have requested them to do. Kimberly-Clark, for example, has a waste treatment facility. It is a major discharger insofar as volume is concerned, but they are doing an excellent job of treating their wastes. Reference was made to that in the report. I mention this specifically because of some of the news releases which have gone out recently which have been misleading. But this particular industry has a discharge that has only about 8 ppm BOD and we think that that is very good. There has never been any problem, as far as we know, from the discharge of this particular industry.

I could go on. There are others. Those are the major ones in the area. But I merely want to point out the fact that neither the industries, the municipalities, nor the State agencies have been sitting still on this during the last few years.

Thank you.

MR. WHITE: Thank you, Dr. Webb.

Mr. Tinsley, any comments?

FROM THE AUDIENCE: Mr. Chairman, would a person be in order--

MR. WHITE: No, sir, it would not.

MR. AUDIENCE: Well, I had an ambiguity in hearing.

MR. WHITE: Let's go off the record, please.

(Off the record.)

MR. WHITE: Let's go back on the record, please.

Mr. Tinsley.

MR. TINSLEY: Only one brief comment. I do feel that it is appropriate to point out that the conclusions and recommendations that have been developed by the conferees are complementary to the programs of the Pollution Control Authority and we are making progress in the area of abating pollution as it is documented. We are always talking in terms of those that are polluting. I feel that it is very beneficial, as Dr. Webb has pointed out,that there are those that are assuming the responsibility that is theirs and are providing proper waste treatment, and we certainly hope that all parties involved in this area will have the same attitude when we start talking to them in terms of a cooperative approach to waste treatment.

MR. WHITE: Thank you.

Mr. Ledbetter?

MR. LEDBETTER: Thank you, Mr. Chairman.

Ladies and gentlemen. We did not come to this conference from Georgia to quibble about the quantity of pollution from various sources or to debate the issue of pollution, but we came to assist in the development of a water pollution abatement program to protect the water resources of this area. We feel this objective has been accomplished and we concur in the conclusions and recommendations just read by Mr. White.

We wish to thank the other conferees as well as our municipalities and industries that attended and participated in this conference and the contributions that they have made and are making toward cleaning up pollution in this area.

So now let us get on with the job of cleaning up the remaining problems.

Thank you, Mr. Chairman.

MR. WHITE: Thank you, Mr. Ledbetter.

I, too, would like to add my thanks to each of the conferees, all of the participants and attendees, for their contribution toward this conference and its achievements. And I hope they will go down as achievements.

We stand adjourned.

(Whereupon, at 3:30 o'clock an adjournment was taken.)

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